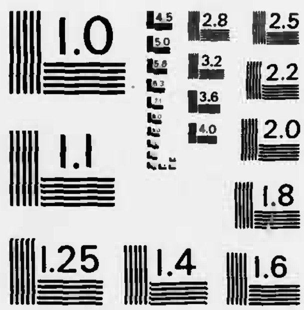
AD-A139 126 METEOROLOGICAL AND CLIMATOLOGICAL CONDITIONS AFFECTING THE VERTICAL STRUC..(U) HANOVER UNIV (GERMANY F R) INST FUER METEOROLOGIE UND KLIMATO.. R ROTH 24 JAN 84 1/1

UNCLASSIFIED DAJA37-82-C-0189 F/G 4/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Meteorological and Climatological Conditions Affecting the Vertical Structure of Visibility in Northern Germany.

Principal Investigator: Prof. Dr. R. Roth
Name of Contractor: University of Hannover

Contract Number: DAJA 37-82-C-0189

S e c o n d Interim Technical Report

October 1982 - January 1984

Hannover 24.02.1984

The research reported in this document has been made possible through the support and sponsorship of the U.S. Government through its European Research Office of the U.S. Army. This report is intended only for the internal management use of the Contractor and the U.S. Government.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

R&D 4033-EN-01

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. A139126	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Meteorological and Climatological Conditions Affecting the Vertical Structure of Visibility in Northern Germany.		5. TYPE OF REPORT & PERIOD COVERED Second Interim Technical Report Oct 82 - Jan 84.
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. Roth.		8. CONTRACT OR GRANT NUMBER(s) DAJA37-82-C-0189
9. PERFORMING ORGANIZATION NAME AND ADDRESS Institute fur Meteorogogie und Klimatologie Universitat Hannover 3000 Hannover 21, West Germany.		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61102A-1T161102-BH57-01
11. CONTROLLING OFFICE NAME AND ADDRESS USARDSG-UK Box 65, FPO NY 09510.		12. REPORT DATE 24 Jan 84
		13. NUMBER OF PAGES 74
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Visibility, Vertical Structure, cloud bases, dewpoint, air masses, clouds, fog.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report described the current status of instrumentation and data acquisition being conducted at Sprakensehl, West Germany. Instruments include visibility meters, thermometers, dewpoint sensors, a cloud ceilometer, and tethersonde packages. Discussions include a description of the measurement system, data processing, and data organization. Summaries of acquired data are given.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Meteorological and Climatological

Conditions Affecting the

Vertical Structure of Visibility

in Northern Germany.

Principal Investigator: Prof. Dr. R. Roth
Name of Contractor: University of Hannover

Contract Number: DAJA 37-82-C-0189

S e c o n d Interim Technical
Report

October 1982 - January 1984

Hannover 24.02.1984

The research reported in this document has been made possible through the support and sponsorship of the U.S. Government through its European Research Office of the U.S. Army. This report is intended only for the internal management use of the Contractor and the U.S. Government.

Contents

1 Current Status

This chapter describes the status of the visibility meters, thermometers and dewpoint sensors and of the data acquisition and -transmission. Function and technical data of the cloud ceilometer (installed in March 1983) and the tethersonde (delivered in October 1983) is presented. In addition temperature and dewpoint measured on the platforms of the mast are compared with those values of the thethersonde.

1.1 Instrumentation

1.1.1 Settlement

In the last technical report it was stated the second height at which measurement takes place is 12m. This is not correct. A check turned out that the scatter volume of the visibility meter, the thermometer and the dewpoint sensor are in the height of 9m.

So the following are the correct heights:

2m, 9m, 80m, 153m, 223m, 297m.

1.1.2 Visibility meter

The number of failures of the electronics decreased, but failures of the visibility meter still occur. Partially they may be caused by high frequencies at the radio mast.

The connection tubes (connection between flash- and

measure part) of 3 visibility meters had to be changed because of heavy rust (guarantee service).

During the time it turned out that the receiver units have to be adjusted quite often by means of an oscilloscope (shortly after replacement of a flash tube and then every 4-6 months) to have the ratio $U_{measure}$ / $U_{reference}$ within certain ranges. Otherwise the upper boundary of 40km or the lower boundary of 50m is not reached. This adjustment becomes necessary because of the seasoning of the flash tube. It even can not be compensated by means of the calibration potentiometer.

A heating at the opening of the housing for the measure and the reference channel and at the tube diaphragm is urgently needed, as snow accumulation or icing cause "fancy" values in wintertime. Fig. 1.1 illustrates the position where additional heating elements should be mounted to avoid icing and/or snow accumulation.

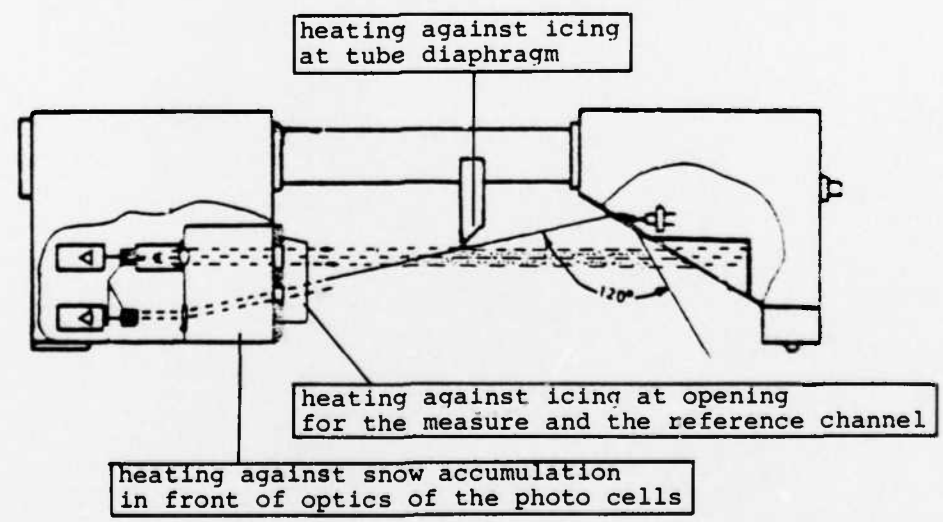


Fig. 1.1 Position of the additional heating elements at the visibility meter

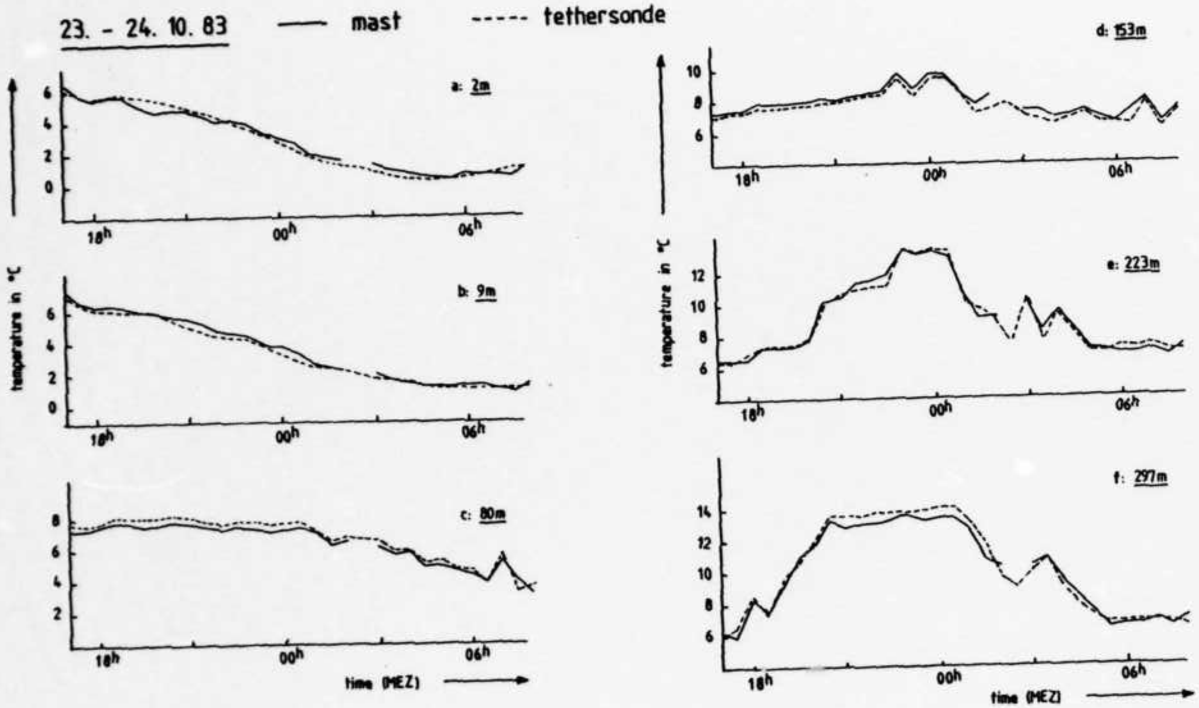
1.1.3 Thermometer

A check of the temperature sensors was made by means of the tethersonde package. In the following temperature curves of the mast thermometers and the corresponding curves of the tethersonde are presented for the heights of 2m, 9m, 80m, 153m, 223m and 297m (Fig. 1.2 a-f). Differences are due to the radiation of the mast and the different exponation of the temperature sensors to the wind. The influence of the mast on temperature measurement will be investigated during the next field experiments. The mast temperatures are 10 min. mean values, the sonde temperatures are actual data. The temperature sensor of the tethersonde package has been calibrated before this comparison.

Fig. 1.2 a - f

Comparison between air temperature measured with the mastsystem and the tethersonde package.

23. - 24. 10. 83 —— mast ----- tethersonde



1.1.4 Dewpoint sensors

Problems with the dewpoint sensors were solved by replacing the LiCl-solution delivered by the manufacturer by a clean (LiCl-aqua dest.) solution. Now the instruments run for nearly one year without any trouble especially as the sensors do nearly not become dirty due to very little industrial dust in the air.

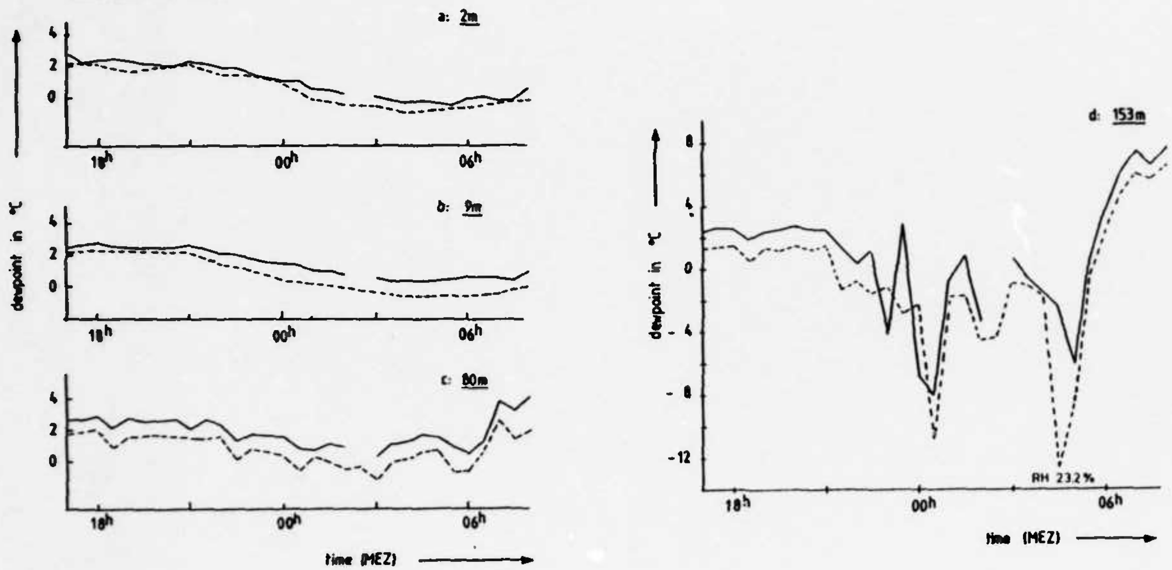
A comparison between these dewpoints and humidity measured by the tethersonde package is shown in the following (curve of the mast dewpoint sensors and corresponding curve of the tethersonde package as in chapt. 1.1.3). The sensor for wet bulb temperature has been calibrated in the same way as the sensor for air temperature.

Fig. 1.3 a-f show the subsidence of very dry air that affects the humidity sensors down to 153m. The lower heights (2m-80m) show quite good coincidence of the mast-system and the tethersonde package, especially as the LiCl dewpoint sensors are of an accuracy of 1K (accuracy of humidity measurements by means of the tethersonde package: 0.5K). Differences occur if the relative humidity becomes very small, i.e. less than about 10% (153m: 4.30h, 223m: 23.00h-3.00h, 297m: 19.00h-3.00h). The dewpoints of the mastsystem are 10 min. values, the dewpoints of the tethersonde package, however, are actual values.

Fig. 1.3 a - d

Comparison between dewpoints measured with the mastsystem and the tethersonde package.

23. - 24. 10. 83 —— mast ---- tethersonde



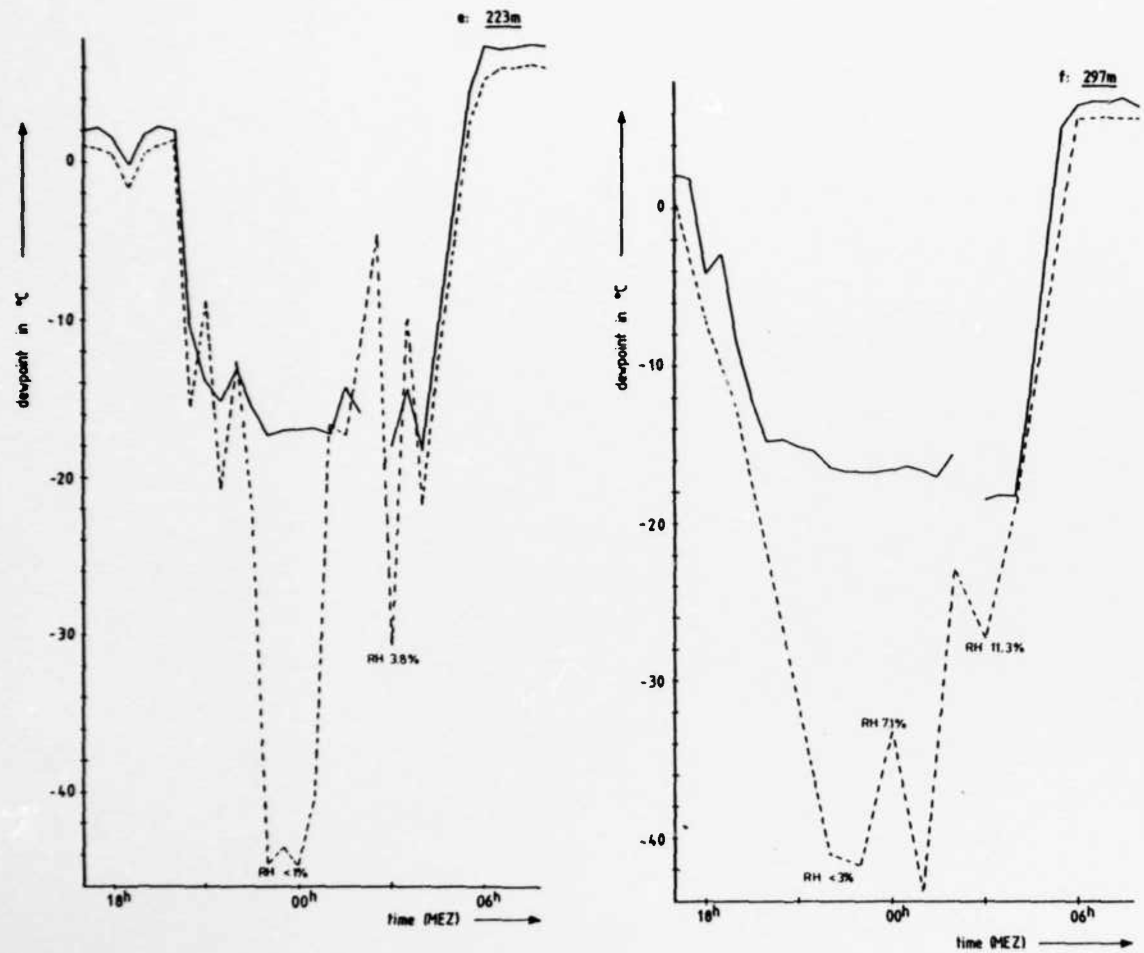

e: 223m
dewpoint in °C
0
-10
-20
-30
-40
RH 3.8%
RH <1%
18h
00h
06h
time (MEZ)
f: 297m
dewpoint in °C
0
-10
-20
-30
-40
RH 11.3%
RH 71%
RH <3%
18h
00h
06h
time (MEZ)

Fig. 1.3 e and f

1.1.5 Cloud ceilometer

The ASEA-cloud-ceilometer runs since 16 March 1983. It consists of a transceiver (QL 1211 A), a control unit (QL 1211 B) and a chart recorder (Linax 1K3). The transceiver is installed beside the visibility meter in two meters height. Control unit and recorder are sited in the caravan.

The cloud ceilometer operates in accordance with the principle of the optical radar: The transmitter emits short light pulses directed upward towards the zenith. When such a light pulse reaches a cloud this causes scattering, a small part of the scattered light is caught by a receiver next to the transmitter. The time required for the light to cover the distance between the transmitter, scatter volume and the receiver is measured and the height of the scatter volume is calculated on the basis of the speed of light.

The receiver determines the presence of scattered light at vertical intervals of 5m within a range between 0 and 1500m. The entire height range is continuously scanned from the lowest to the highest interval, i.e. from 0-5m to 1495-1500m. In this way one or several layers of clouds, one above the other, can be continuously recordedup to 1500m.

Fig. 1.4 Transceiver QL 1211 A with removed cover. Right window on the top: optics for the transmitter, left window: optics for the receiver.

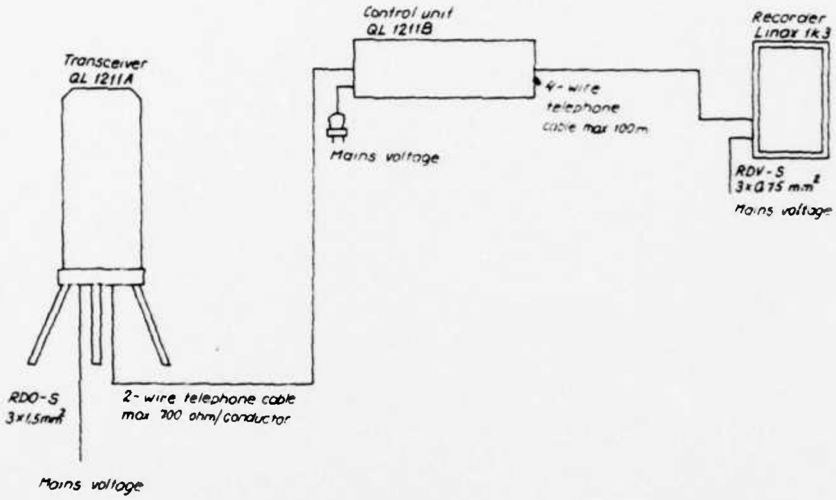


Fig. 1.5 Connections between control unit, transceiver and chart recorder.

A condensation of technical data of the cloud ceilometer is presented in the following:

General	Measuring range	10 to 1500m
	Measuring accuracy when aimed at a defined object	$\pm$ 5m
	Measuring time	45s
	Measuring interval (cycle time)	47s
	Ambient temperature	-30 to +50°C *
	Supply voltage	110, 127, 220 or 240V 50 or 60 Hz
	Power consumption	Electronics: 30W Heating elements: 300W
	Weight including cover	38kg

* Gradually reduced performance from +40 to +50°C

Transmitter	Light source	GaAs injection laser diode
	Wavelenght	906 $\pm$ 4nm
	Pulse output	Typ. 20W
	Pulse lenght	50ns
	Pulse repetition frequency	1951 Hz or 3902 Hz
	Optics	1:2.0/200
	Divergence	2 mrad approx. (after optics)
Receiver	Detector	Avalanche photodiode (Si)
	Optical bandpass filter	$\approx 906.0^{+6}_{-2}$ nm $\approx$12nm
	Optics	1:3.8/380
	Field of view	2 mrad approx.

The thickness of the measured layer and the number of the layers is recorded only on chart paper. An examplary recording is shown in Fig. 1.6 .

Only the height of the lowest scattering, i.e. the height of the cloud base, is recorded on magnetic tape. A plot of the cloud base is presented in Fig. 1.7 for the same time interval as in Fig. 1.6 .

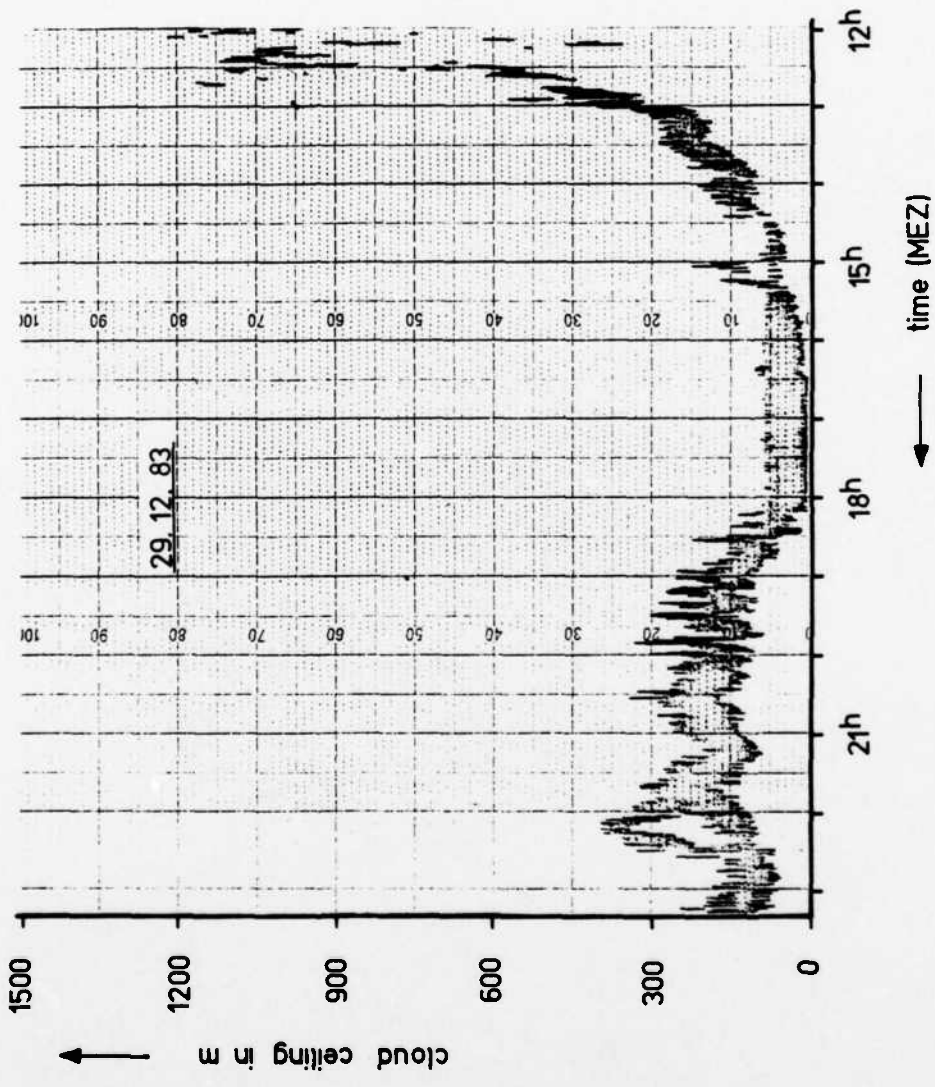


Fig. 1.6   Exemplary registration of the cloud ceiling.

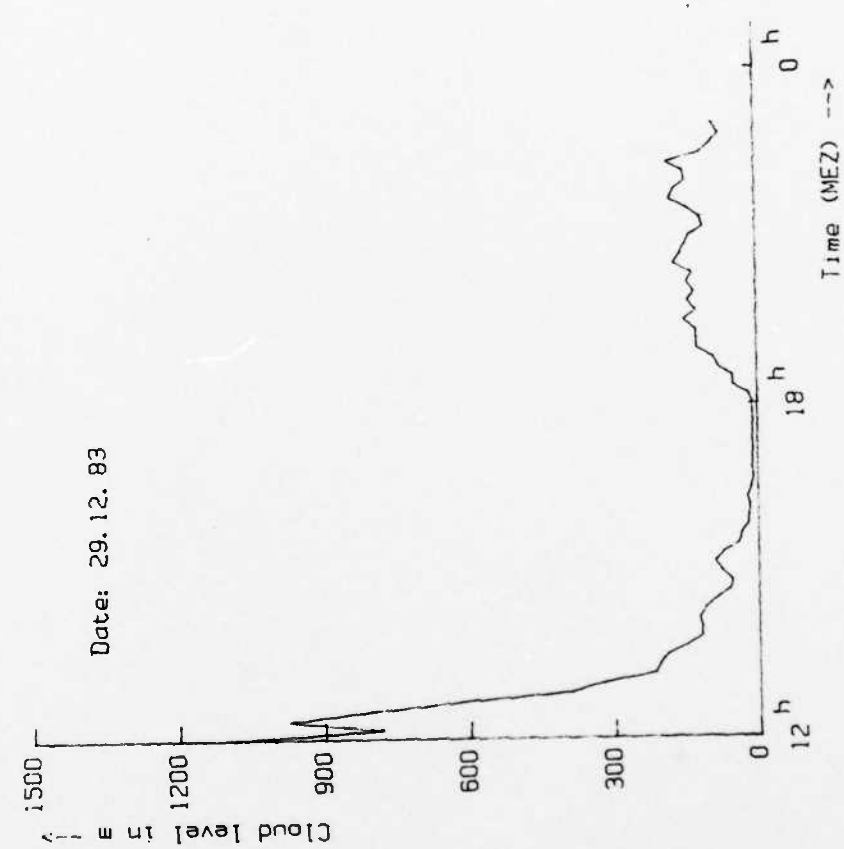


Fig. 1.7 Plot of the height of the cloud base for the time interval corresponding to Fig. 1.6.

1.1.6 Tethersonde package

The tethersonde package TS-1A-1-SP (made by AIR. CO., USA) has been delivered by Wittich & Visser (Netherlands) in October 1983. Its application is described in chapter 2.

The tethersonde package measures dry-bulb temperature, wet-bulb depression, barometric pressure, wind speed and wind direction utilizing sophisticated integrated circuitry to condition and then transmit data from the sensors.

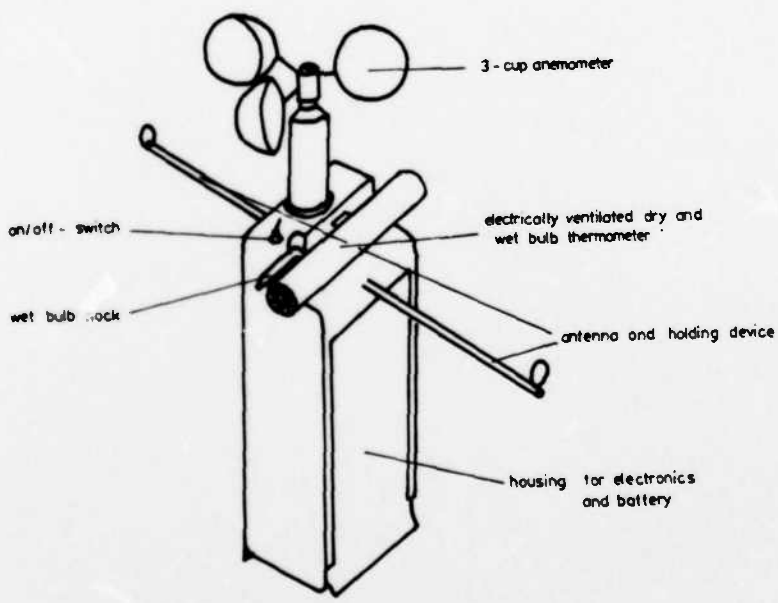


Fig. 1.8 Tethersonde package.
Sensors and housing of the electronics and the battery.

Dry and wet-bulb temperatures are sensed by precision matched thermistors. Wind speed is measured by a 3-cup anemometer and wind direction by a magnetic compass. Pressure change is detected by a temperature-compensated aneroid transducer. Height may be determined approximately from the indicated pressure change sensor. Trouble with the temperature compensation is described below.

An analog multiplexer selects each sensor voltage in time sequence to modulate a voltage controlled oscillator. One (selectable) sensor may be sampled continuously . A crystal controlled 403MHz FM transmitter is used to telemeter audio FM data to the ground on two audio frequencies. Commutation rate is adjustable from one frame per second to one frame per minute. Normal commutation rate is three frames, consisting of eight data channels each, per minute.

The data are received by a ground station that is given on loan to the institute by the Fraunhofer Gesellschaft. The ground station resolves the incoming audio frequency signal into its two component frequencies and then converts these into both electrical analog and digital form for output. One of the two incoming frequencies (the A data channel) contains information from all of the sensors in time multiplex format; the other (the B channel) contains continuous information from one sensor only. A microcomputer and additional circuitry in the ground station process the data so that they may be recorded for instance by means of a HP 85 calculator.

Specifications:

Tethersonde package

Sensors	
Dry and wet-bulb temperature	-50° to +50°C ± 0.5°C
Pressure	0 to 100 hPa ±1hPa
Wind speed	0.5 to 20m/s ±0.25m/s
Wind direction	0 - 360° ±5°
Telemetry Link	
Modulation	PAM-FM (Time Multiplex)
Frequency	IRIG CHANNEL 8 (3kHz ±7.5%)
Format	Time multiplex on Channel A, continuous on B
Transmitter	
Frequency	400 - 420mHz FM
Frequency Stability	(-30 to +60°C) 0.0005%
Modulation	16 F3
Power Output	5mW
Construction	
Size	9 x 12 x 48cm
Weight	1000g

Ground Receiver

Frequency Range	400 - 420mHz FM
Number of Channels	4
Frequency Stability	(0° to +60°C) 0.0005%
Channel Spacing	25kHz
Sensitivity	0.5μV
Selectivity	60dB
Audio Output	500mW
Size	15 x 11.5 x 44.5cm
Antenna	15cm whip with ground plain
Microcomputer	Intel 8080A with 2500 word memory

Fig. 1.9 shows the temperature dependence of the pressure sensor of this sonde: At 0 min. the sonde is cooled down to -18°C, 32 min. after it is warmed up to +22°C. The pressure shows a decrease of about 20mbar for a cooling of 40K. For

the warming the pressure decreases about further 15mbar after a short increase. 35min. after the temperature sensor reached its final temperature the pressure is on the same level as before cooling.

Although these temperature differences are extremely high it looks as if the pressure sensor is not temperature compensated. AIR. CO., USA and Wittich & Visser, Netherlands are going to solve this problem.

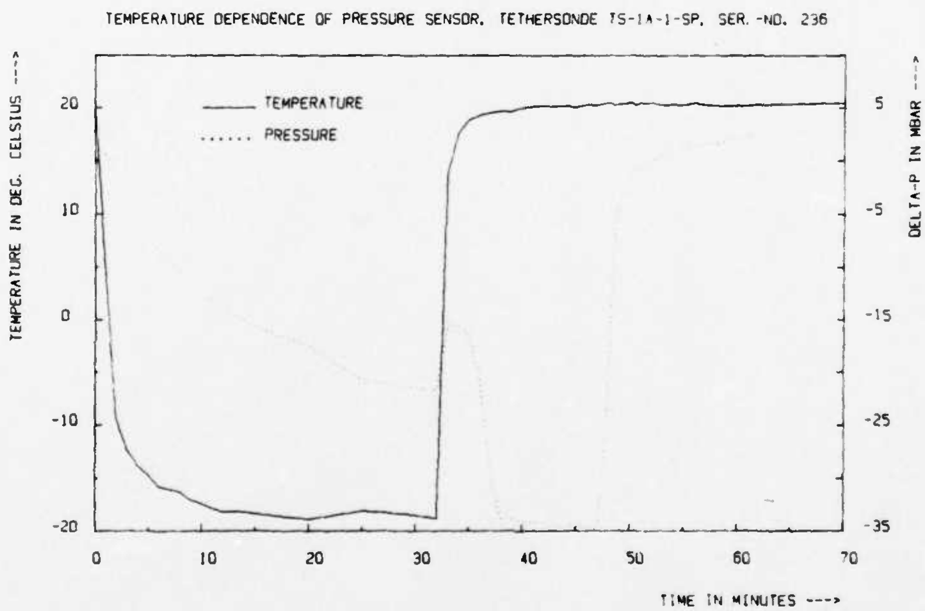


Fig. 1.9

1.1.7 Excess voltage protection

During thunderstorms the excess voltage protection for the visibility meters and the data acquisition (described in the last technical report) proved as very safe. There were no damages of the electronics caused by lightning. The modem of the Deutsche Bundespost, however, that is not protected failed three times because of overvoltages on the telephone line.

1.2 Data acquisition/transmission

Although the HP 9915 program has been presented in the last technical report it is printed out in this report as well, because the registration of the cloud ceiling and subroutines for data transmission are added.

Before the program listing (Tab. 1.1) a simplified flow chart of the HP 9915 program "Autost" is shown in Fig. 1.10.1. Flow charts of the subprograms for the datatransmission are presented in Fig. 1.10.2.

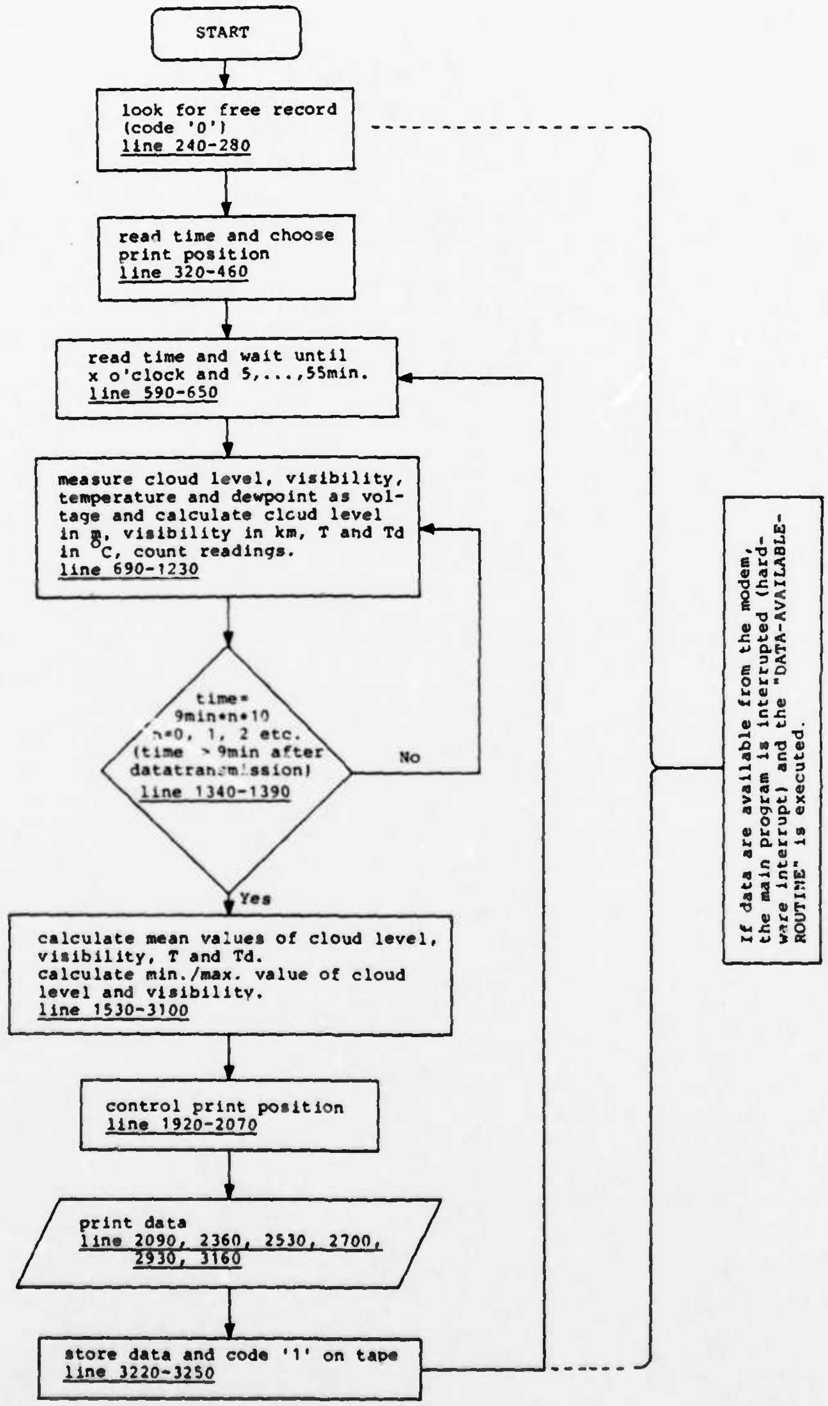


Fig. 1.10.1 Flow chart of the program "Autost".

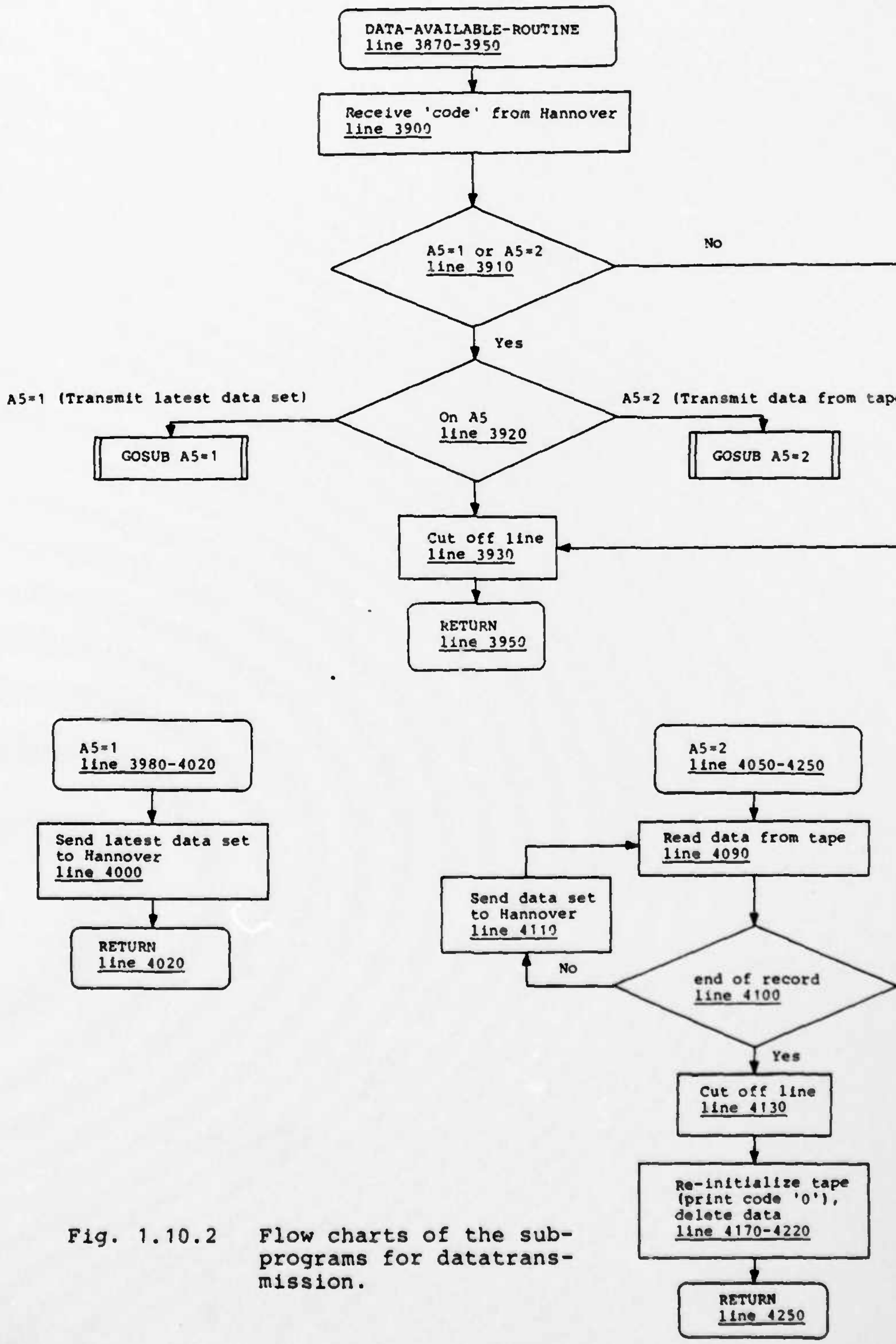


Fig. 1.10.2 Flow charts of the subprograms for datatransmission.

Table 1.1 Program listing of the program "Autost" (page 25 - 35)

```
10 ! **** PROGRAM "Autost" ****
20 ! ------------------------------------------------------------------
30 ! Measurement of cloud level and visibility, temperature and dewpoint
40 ! at six heights including datatransmission via modem of the Deutsche
50 ! Bundespost from Sprakensehl to Hannover
60 ! ------------------------------------------------------------------
70 ON ERROR GOSUB 4280
80 ASSIGN# 1 TO "SPR1"
90 DIM S(60,6),T(60,6),T1(60,6),S9(6),S8(60),C1(60),S3(6),S4(6),T9(6),T8(6)
100 DIM A$[100],Z$[100],B$[100],D$[100]
110 INTEGER A(6),B(6),C(6),D(6),E(6),F(6),G(6)
120 IOBUFFER A$ @ IOBUFFER Z$
130 A5=0 @ A6=1
140 A=0 @ B=0
150 J9=84
160 ASSERT 10;1
170 CONTROL 10,16 ; 130
180 CONTROL 10,5 ; 18
190 ON INTR 10 GOSUB 3870 ! DATA-AVAILABLE-ROUTINE
200 ENABLE INTR 10;20
210 ! ---------------------------
220 ! SEARCH 1ST EMPTY DATA-RECORD
230 ! ---------------------------
240 S=SLITE(0,1)
250 FOR S0=1 TO 1930
260 READ# 1,S0 ; A9,A$
270 IF A9=0 THEN S=SLITE(0,-1) @ GOTO 320
280 NEXT S0
290 ! -------------
300 ! PRINT POSITION
310 ! -------------
320 S=SLITE(1,1)
330 OUTPUT 709 ;"TO"
340 T$="TO"
350 ENTER 709 ; T$
360 T1=VAL(T$[11])
370 IF T1=4 THEN 400
380 WAIT 100
390 GOTO 350
400 T3=VAL(T$[10])
410 IF T3=54 THEN OUTPUT 701 USING "4/" @ GOTO 510
420 IF T3=4 THEN OUTPUT 701 USING "13/" @ GOTO 510
430 IF T3=14 THEN OUTPUT 701 USING "22/" @ GOTO 510
440 IF T3=24 THEN OUTPUT 701 USING "31/" @ GOTO 510
450 IF T3=34 THEN OUTPUT 701 USING "40/" @ GOTO 510
460 IF T3=44 THEN OUTPUT 701 USING "49/" @ GOTO 510
470 ! ==============================================================
```

```
480 ! ------------
490 ! PROGRAM Main
500 ! ------------
510 S=SLITE(I,-I)
520 R9=S0-I
530 S=SLITE(3,-I) @ S=SLITE(2,1)
540 R9=R9+1 ! RECORD-NO.
550 CONTROL A$,I ; 0
560 FOR I=0 TO 6
570 Z(I)=0 ! RESET NUMBER OF READINGS
580 NEXT I
590 ENTER 709 ; T$
600 T1=VAL(T$[11])
610 IF T1=5 THEN 640
620 WAIT 100
630 GOTO 590
640 I1=0
650 S=SLITE(2,-1)
660 ! -----------
670 ! CLOUD LEVEL
680 ! -----------
690 S=SLITE(3,I)
700 P1=6
710 GOSUB 3280 ! CALL Cloud level
720 C1(Z(6))=1500/5.08*P ! Convert ASEA output voltage to cloud level
730 IF P>5.08 THEN C1(Z(6))=9999 ELSE Z(6)=Z(6)+1
740 ! ----------
750 ! VISIBILITY
760 ! ----------
770 FOR I=0 TO 5
780 J=0
790 IF I>2 THEN J=17
800 P1=I+26+J
810 Y=0
820 GOSUB 3730 ! CALL Ohm (STATUS-REQUEST)
830 IF P<500 THEN 920
840 P1=I
850 GOSUB 3280 ! CALL Visibility
860 IF P>10.5 THEN S(Z(I),I)=99.99 @ GOTO 920
870 S1=.04*10^(.3*P) ! Convert AEG output voltage to visibility
880 S(Z(I),I)=S1
890 P1=I+26+J
900 GOSUB 3730 ! CALL Ohm (STATUS-REQUEST)
910 IF P<500 THEN S(Z(I),I)=99.99 ELSE Z(I)=Z(I)+1
920 NEXT I
```

```
930 ! -----------
940 ! TEMPERATURE
950 ! -----------
960 FOR I=20 TO 25
970 P1=1
980 Y=100+(I-20)*100
990 GOSUB 3340 ! CALL Temperature
1000 T(Z1,I-20)=P
1010 IF P=9.E19 THEN T(Z1,I-20)=49.99
1020 NEXT I
1030 ! --------
1040 ! DEWPOINT
1050 ! --------
1060 P2=100
1070 FOR I=40 TO 45
1080 IF T(Z1,I-40)=49.99 THEN 1210
1090 P1=1
1100 Y=100+(I-40)*100
1110 GOSUB 3540 ! CALL Dewpoint
1120 IF P=9.E19 THEN 1210
1130 C5=P+273.15
1140 T5=T(Z1,I-40)+273.15
1150 T2=(C5+71)/1.39
1160 IF C5>=280 AND C5<=298 THEN T1(Z1,I-40)=T2*(C5/T5)^(1/21.313)-273.15
1170 IF C5>298 AND C5<312 THEN T1(Z1,I-40)=T2*(C5/T5)^(1/20.145)-273.15
1180 IF C5>=312 AND C5<=336 THEN T1(Z1,I-40)=T2*(C5/T5)^(1/18.815)-273.15
1190 IF C5<280 OR C5>336 THEN T1(Z1,I-40)=49.99
1200 GOTO 1220
1210 T1(Z1,I-40)=49.99
1220 NEXT I
1230 Z1=Z1+1
1240 ! --------------------
1250 ! CONTROL MODEM STATUS
1260 ! --------------------
1270 STATUS 10,3 ; M
1280 IF BIT(M,1)=1 THEN WAIT 10000 @ GOTO 1300
1290 GOTO 1310
1300 RESET 10 @ CONTROL 10,5 ; 18@ CONTROL 10,16 ; 130@ ASSERT 10;1 @ ENABLE INTR 10;20
1310 ! ------------
1320 ! TIME REQUEST
1330 ! ------------
1340 OUTPUT 709 ;"TO"
1350 T$="TO"
1360 ENTER 709 ; T$
1370 T2=VAL(T$[11])
1380 IF T1-T2=1 THEN 1430
1390 GOTO 700
```

```
1400 ! -------------
1410 ! TIME AND DATE
1420 ! -------------
1430 C1=VAL(T$[1]) ! DAY
1440 C2=VAL(T$[4]) ! MONTH
1450 C3=VAL(T$[7]) ! HOUR
1460 C4=VAL(T$[10])-4 ! MINUTE
1470 S8(0)=C3+C4/100
1480 S8(1)=C1+C2/100
1490 S8(2)=J9+Z1/100
1500 ! ------------------
1510 ! CLOUD LEVEL (MEAN)
1520 ! ------------------
1530 A7=0
1540 FOR Z=0 TO Z(6)-1
1550 IF C1(Z)=9999 THEN 1570
1560 A7=A7+C1(Z)
1570 NEXT Z
1580 IF A7=0 THEN S8(3)=9999 @ GOTO 1630
1590 S8(3)=A7/Z(6)
1600 ! ------------------
1610 ! CLOUD LEVEL (MIN.)
1620 ! ------------------
1630 S2=1600
1640 FOR Z=0 TO Z(6)-1
1650 IF S2<C1(Z) OR C1(Z)=9999 THEN 1680
1660 S2=C1(Z)
1670 S8(4)=S2
1680 NEXT Z
1690 IF S2=1600 THEN S8(4)=9999
1700 ! ------------------
1710 ! CLOUD LEVEL (MAX.)
1720 ! ------------------
1730 S2=0
1740 FOR Z=0 TO Z(6)-1
1750 IF S2>C1(Z) OR C1(Z)=9999 THEN 1780
1760 S2=C1(Z)
1770 S8(5)=S2
1780 NEXT Z
1790 IF S2=0 THEN S8(5)=9999
1800 FOR I=0 TO 2
1810 A(I)=INT(S8(I)*100)
1820 OUTPUT A$ USING "#,W" ; A(I)
1830 OUTPUT Z$ USING "#,2D.2D,2X" ; S8(I)
1840 NEXT I
1850 FOR I=3 TO 5
1860 OUTPUT A$ USING "#,W" ; S8(I)
1870 OUTPUT Z$ USING "#,5D,2X" ; S8(I)
1880 NEXT I
```

```
1890 ! ----------------------
1900 ! CONTROL PRINT POSITION
1910 ! ----------------------
1920 IF A=0 AND B=0 THEN 2060
1930 IF FP(A(0)/100)-A=.1 AND A(0)-B#50 AND A(0)-B#10 AND A(0)-B#-2350 THEN 1950
1940 GOTO 1960
1950 OUTPUT 701 USING "71/" @ GOTO 2060
1960 IF FP(A(0)/100)-A=.2 THEN OUTPUT 701 USING "8/" @ GOTO 2050
1970 IF FP(A(0)/100)-A=.3 THEN OUTPUT 701 USING "17/" @ GOTO 2050
1980 IF FP(A(0)/100)-A=.4 THEN OUTPUT 701 USING "26/" @ GOTO 2050
1990 IF FP(A(0)/100)-A=.5 THEN OUTPUT 701 USING "35/" @ GOTO 2050
2000 IF FP(A(0)/100)-A=0 AND A(0)-B#0 THEN OUTPUT 701 USING "44/" @ GOTO 2050
2010 IF FP(A(0)/100)-A=-.1 THEN OUTPUT 701 USING "35/" @ GOTO 2050
2020 IF FP(A(0)/100)-A=-.2 THEN OUTPUT 701 USING "26/" @ GOTO 2050
2030 IF FP(A(0)/100)-A=-.3 THEN OUTPUT 701 USING "17/" @ GOTO 2050
2040 IF FP(A(0)/100)-A=-.4 THEN OUTPUT 701 USING "8/" @ GOTO 2050
2050 IF INT(A(0)/100)-INT(B/100)#0 THEN OUTPUT 701 USING "17/"
2060 A=FP(A(0)/100)
2070 B=A(0)
2080 OUTPUT 701 USING "#,15X"
2090 TRANSFER Z$ TO 701 FHS
2100 ! -----------------
2110 ! VISIBILITY (MEAN)
2120 ! -----------------
2130 I0=0
2140 FOR I=0 TO 5
2150 A7=0
2160 FOR Z=0 TO Z(I)-1
2170 IF S(Z,I)=99.99 THEN 2190
2180 A7=A7+S(Z,I)
2190 NEXT Z
2200 IF A7=0 THEN 2230
2210 S9(I)=A7/Z(I)
2220 GOTO 2240
2230 S9(I)=99.99
2240 B(I)=INT(S9(I)*100)
2250 OUTPUT A$ USING "#,W" ; B(I)
2260 OUTPUT Z$ USING "#,2D.2D,2X" ; S9(I)
2270 NEXT I
2280 OUTPUT 701 USING "#,15X"
2290 TRANSFER Z$ TO 701 FHS
2300 FOR I=0 TO 5
2310 C(I)=INT(Z(I))
2320 OUTPUT A$ USING "#,W" ; C(I)
2330 OUTPUT Z$ USING "#,2D,5X" ; Z(I)
2340 NEXT I
2350 OUTPUT 701 USING "#,15X"
2360 TRANSFER Z$ TO 701 FHS
```

```
2370 ! -----------------
2380 ! VISIBILITY (MIN.)
2390 ! -----------------
2400 FOR I=0 TO 5
2410 S2=50
2420 FOR Z=0 TO Z(I)-1
2430 IF S2<S(Z,I) OR S(Z,I)=99.99 THEN 2460
2440 S2=S(Z,I)
2450 S3(I)=S2
2460 NEXT Z
2470 IF S2=50 THEN S3(I)=99.99
2480 D(I)=INT(S3(I)*100)
2490 OUTPUT A$ USING "#,W" ; D(I)
2500 OUTPUT Z$ USING "#,2D.2D,2X" ; S3(I)
2510 NEXT I
2520 OUTPUT 701 USING "#,15X"
2530 TRANSFER Z$ TO 701 FHS
2540 ! -----------------
2550 ! VISIBILITY (MAX.)
2560 ! -----------------
2570 FOR I=0 TO 5
2580 S2=0
2590 FOR Z=0 TO Z(I)-1
2600 IF S2>=S(Z,I) OR S(Z,I)=99.99 THEN 2630
2610 S2=S(Z,I)
2620 S4(I)=S2
2630 NEXT Z
2640 IF S2=0 THEN S4(I)=99.99
2650 E(I)=INT(S4(I)*100)
2660 OUTPUT A$ USING "#,W" ; E(I)
2670 OUTPUT Z$ USING "#,2D.2D,2X" ; S4(I)
2680 NEXT I
2690 OUTPUT 701 USING "#,15X"
2700 TRANSFER Z$ TO 701 FHS
2710 ! ------------------
2720 ! TEMPERATURE (MEAN)
2730 ! ------------------
2740 FOR I=0 TO 5
2750 Z0=0
2760 A7=0
2770 FOR Z=0 TO Z1-1
2780 IF T(Z,I)=49.99 THEN 2810
2790 A7=A7+T(Z,I)
2800 GOTO 2820
2810 Z0=Z0+1
2820 NEXT Z
2830 IF A7=0 THEN 2860
2840 T9(I)=A7/(Z1-Z0)
```

```
2850 GOTO 2870
2860 T9(I)=49.99
2870 F(I)=INT((T9(I)+50)*100)
2880 OUTPUT A$ USING "#,W" ; F(I)
2890 IF T9(I)=49.99 THEN T9(I)=99.99
2900 OUTPUT I$ USING "#,3D.2D, X" ; T9(I)
2910 NEXT I
2920 OUTPUT 701 USING "#,14X"
2930 TRANSFER I$ TO 701 FHS
2940 ! ---------------
2950 ! DEWPOINT (MEAN)
2960 ! ---------------
2970 FOR I=0 TO 5
2980 Z0=0
2990 A7=0
3000 FOR Z=0 TO Z1-1
3010 IF T1(Z,I)=49.99 THEN 3040
3020 A7=A7+T1(Z,I)
3030 GOTO 3050
3040 Z0=Z0+1
3050 NEXT Z
3060 IF A7=0 THEN 3090
3070 T8(I)=A7/(Z1-Z0)
3080 GOTO 3100
3090 T8(I)=49.99
3100 G(I)=INT((T8(I)+50)*100)
3110 OUTPUT A$ USING "#,W" ; G(I)
3120 IF T8(I)=49.99 THEN T8(I)=99.99
3130 OUTPUT I$ USING "#,3D.2D, X" ; T8(I)
3140 NEXT I
3150 OUTPUT 701 USING "#,14X"
3160 TRANSFER I$ TO 701 FHS
3170 OUTPUT 701 ;CHR$(10)
3180 D$=A$
3190 ! ----------
3200 ! STORE DATA
3210 ! ----------
3220 IF R9>1930 THEN 3250
3230 PRINT# 1,R9 ; 1,A$
3240 IF C2=12 AND C1=31 AND C3=23 AND VAL(T$[10])=54 THEN J9=J9+1 ! YEAR
3250 GOTO 530
3260 END
3270 ! ============================================================
```

S U B P R O G R A M S

Subprograms for measurement of cloud level, visibility, temperature and dewpoint:

```
3280 ! SUBPROGRAM Cloud level/Visibility
3290 OUTPUT 709 USING "AA,DDD" ; "AC";INT(P1)
3300 OUTPUT 709 ;"VR5VN1VA1VF1VD5VC0VS0VM0VT3" ! 3497 SETUP & TRG
3310 ENTER 709 ; P
3320 RETURN
3330 ! ----------------------------------------------------------------

3340 ! SUBPROGRAM Temperature
3350 P1=INT(P1)
3360 OUTPUT 709 USING "AA,DDD,A,DDD" ; "AC";P1;",";P1+10
3370 OUTPUT 709 ;"VC0VR5VN1VA1VF1VD5VS0VM0VT3"
3380 ENTER 709 ; Q2 ! Offset
3390 OUTPUT 709 ;"VC1"
3400 WAIT Y
3410 OUTPUT 709 ;"VT3"
3420 ENTER 709 ; Q9
3430 Q8=(Q9-Q2)*10^5
3440 OUTPUT 709 ;"VC0"
3450 IF Q8<120000 AND Q8>41.081 THEN GOTO 3470
3460 P=9.E19 @ GOTO 3520 ! Return with overload
3470 Q4=LOG(Q8)
3480 Q1=.0014684
3490 Q2=.00023827
3500 Q3=.00000010112
3510 P=1/(Q1+Q4*(Q2+Q4*Q4*Q3))-273.15
3520 RETURN
3530 ! ----------------------------------------------------------------
```

```
3540 ! SUBPROGRAM Dewpoint
3550 GOSUB 3730 ! CALL Ohm
3560 IF P>500 THEN GOTO 3590
3570 O7=P/P2
3580 IF O7>=.1849316 AND O7<=3.9026 THEN GOTO 3600
3590 P=9.E19 @ GOTO 3710 ! Return with overload
3600 IF O7<1 THEN 3660
3610 O3=3367.82144088 ! Temp>0
3620 O4=13065764.8633
3630 O5=-1723543.60565
3640 P=O3-SQR(O4+O5*O7)
3650 GOTO 3710 ! RETURN
3660 O2=-241.996759172 ! Temp<0
3670 O3=222.560617915
3680 O4=25.2488238815
3690 O5=-5.81268262546
3700 P=O2+O7*(O3+O7*(O4+O7*O5))
3710 RETURN
3720 ! ---------------------------------------------------------------


3730 ! SUBPROGRAM Ohm
3740 OUTPUT 709 USING "AA,DDD,A,DDD" ; "AC";INT(P1);",";INT(P1+10)
3750 OUTPUT 709 ;"VC0VR5VN1VA1VF1VO5VS0VN0VT3"
3760 ENTER 709 ; O5 ! Offset
3770 IF ABS(O5)>.5 THEN P=9.E19 @ GOTO 3840 ! Return with overload
3780 OUTPUT 709 ;"VC3"
3790 WAIT Y
3800 OUTPUT 709 ;"VT3"
3810 ENTER 709 ; P
3820 OUTPUT 709 ;"VC0" ! Turn off 3497 current source
3830 P=(P-O5)*10^3
3840 RETURN
3850 ! ---------------------------------------------------------------
```

Subroutines for data transmission:

```
3860 ! DATA-AVAILABLE-ROUTINE
3870 S=SLITE(3,-1) @ S=SLITE(4,1)
3880 SET TIMEOUT 10;10000
3890 ON TIMEOUT 10 GOTO 4310
3900 ENTER 10 USING "Z,4Z" ; A5,A6
3910 IF A5=1 OR A5=2 THEN 3920 ELSE GOTO 3930
3920 ON A5 GOSUB 3980,4050
3930 RESET 10 @ CONTROL 10,5 ; 18@ CONTROL 10,16 ; 130@ ASSERT 10;1
3940 S=SLITE(4,-1) @ S=SLITE(3,1) @ OFF TIMEOUT 10
3950 STATUS 10,1 ; M@ ENABLE INTR 10;20 @ RETURN
3960 ! ---------------------------------------------------------------


3970 ! SUBROUTINE FOR A5=1 (Transmit latest data-set)
3980 S=SLITE(5,1)
3990 B$=D$
4000 OUTPUT 10 USING "#,84A" ; B$
4010 S=SLITE(5,-1)
4020 RETURN
4030 ! ---------------------------------------------------------------


4040 ! SUBROUTINE FOR A5=2 (Transmit data from tape)
4050 S=SLITE(6,1)
4060 K9=A6-1
4070 ASSIGN# 2 TO "SPRI"
4080 K9=K9+1
4090 READ# 2,K9 ; E1,B$
4100 IF E1=0 OR K9=1930 THEN 4130
4110 OUTPUT 10 USING "#,84A" ; B$
4120 GOTO 4080
4130 RESET 10
4140 S=SLITE(6,-1) @ S=SLITE(4,-1) @ S=SLITE(7,1)
4150 R9=A6
4160 ASSIGN# 2 TO *
4170 ASSIGN# 3 TO "SPRI"
4180 H$="0"
4190 FOR R=A6 TO K9
4200 PRINT# 3,R ; 0,H$
4210 NEXT R
4220 ASSIGN# 3 TO *
4230 A5=0 @ A6=1
4240 S=SLITE(7,-1)
4250 RETURN
4260 ! ---------------------------------------------------------------
```

Error-subroutine:

```
4270 ! ERROR-SUBROUTINE
4280 OUTPUT 701 ;"ERRN";ERRN;"ERRL";ERRL
4290 IF ERRN>14 AND ERRN<30 THEN AUTOSTART
4300 IF ERRN>59 AND ERRN<76 THEN STOP
4310 RESET 10
4320 CONTROL 10,5 ; 18@ CONTROL 10,16 ; 130@ ASSERT 10;1
4330 STATUS 10,1 ; M@ ENABLE INTR 10;20 @ OFF TIMEOUT 10 @ RETURN
4340 END
```

A program to receive Sprakensehl data is printed out in the following (Tab. 1.2). It is possible to get the latest data set (A5=1) at any time.*) But it is impossible to get the same data from tape twice. When the data from tape are transmitted, the tape is re-initialized, i.e. the data are deleted. The program listing is preceeded by a flow chart (Fig. 1.11).

The transmission of the latest data set is useful to get the status of all instruments. So failures are recognized very soon and the duration of break downs is minimal. In addition transmission of data from tape saves a lot of time, because it is not necessary to fetch the data cartridge from Sprakensehl and replace it by a new one.

*) The data are available under telephone number 05837 580.

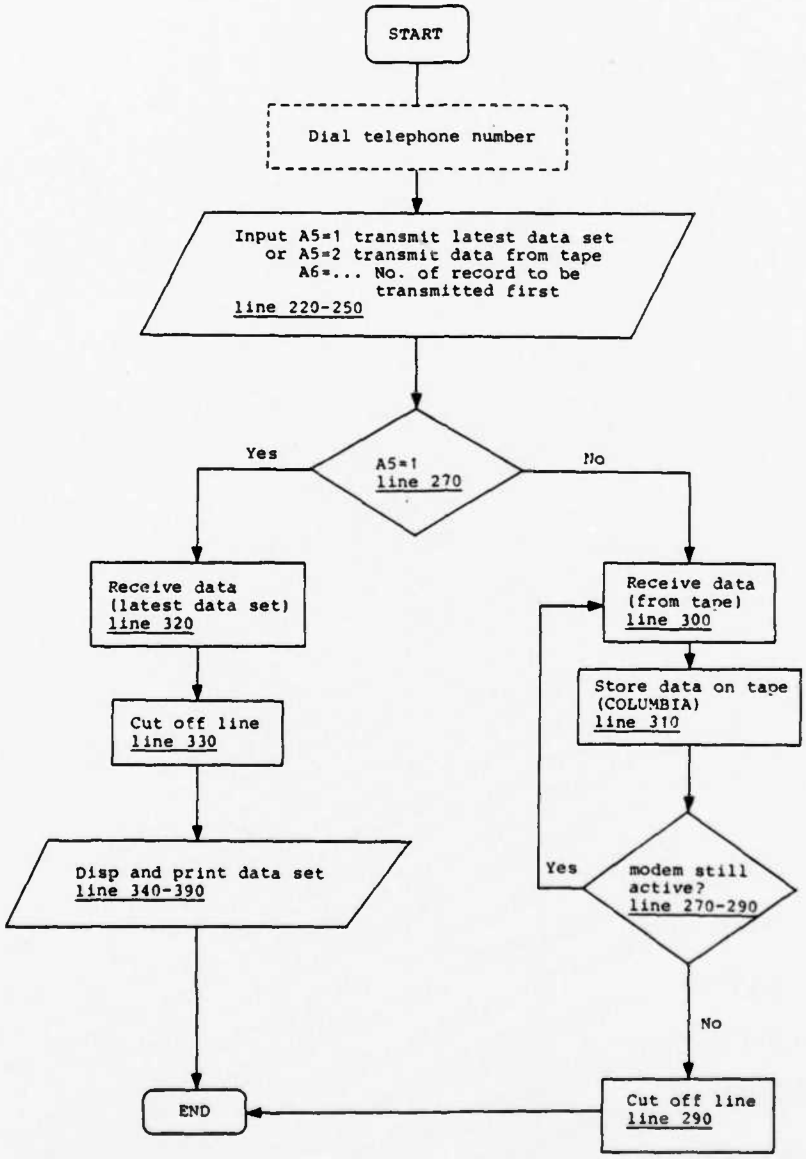


Fig. 1.10.3 Flow chart of the program "MODEM" which is used to receive data from Sprakensehl.

Table 1.2 Program listing of the program "MODEM".

```
10 ! **** PROGRAM "MODEM" ****
20 ! ----------------------------------------------------------
30 ! Data transmission from Sprakensehl to Hannover (1200 bit/s)
40 ! ----------------------------------------------------------
50 RESET 9
60 ASSERT 9;1
70 CONTROL 9,3 ; 15
80 RESET 10
90 ASSERT 10;1
100 CONTROL 10,3 ; 80 CONTROL 10,5 ; 180 CONTROL 10,16 ; 130
110 DIM A$[5],Z$[100]
120 IOBUFFER Z$
130 INTEGER A(7),B(7),C(7),D(7),E(7),F(7)
140 A6=0
150 A$="XXXXX"
160 CLEAR @ DISP "Dial telephone number 05837/580"
170 DISP
180 DISP "A5=1: Transmit latest data set"
190 DISP "A5=2: Transmit data from tape"
200 DISP
210 DISP "A5=...";
220 INPUT A5
230 IF A5=1 THEN 260
240 DISP "Record-Nr.:...";
250 INPUT A6
260 OUTPUT 10 USING "Z,4Z" ; A5,A6
270 IF A5=1 THEN 320
280 STATUS 10,3 ; M
290 IF NOT BIT(M,3) THEN RESET 10 @ GOTO 400
300 ENTER 10 USING "#,84A" ; Z$
310 OUTPUT 9 USING "#,84A,5A" ; Z$,A$ @ GOTO 280
320 ENTER 10 USING "#,84A" ; Z$
330 RESET 10
340 FOR I=1 TO 7
350 ENTER Z$ USING "#,6(W)" ; A(I),B(I),C(I),D(I),E(I),F(I)
360 DISP USING 380 ; A(I),B(I),C(I),D(I),E(I),F(I)
370 NEXT I
380 IMAGE 6(5D)
390 COPY
400 END
```

2 Periods of intensive measurements

Additional measurements with the tethersonde package and a monostatic sodar took place during two nights in October 1983 to get more detailed information about the meteorological parameter affecting visibility.

2.1 Description of the measurement system

Before the discussion a brief description of the technique of measurement by means of the tethersonde package with the liftsystem and the sodar at the Sprakensehl radio mast is presented.

2.1.1 Mechanical construction of the liftsystem

The liftsystem consists of an endless rope that is stretched between a holding device on the ground and a telescope arm in the height of 297m. The distance between holding device and mast base is 30m, so the inclination of the rope is 5°.

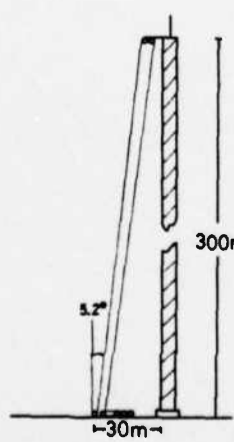


Fig. 2.1 General survey of the liftsystem.

The rope is driven by a three phase A.C. motor which is mounted on a concrete slab. A counting wheel that is driven by the rope is used to define the actual height of the sonde package. One turn of the wheel is equal to the transport of the rope about 0.5m. Because of the elongation of the rope by wind stress the absolute accuracy of the height measurement is ± 1m. The construction of the telescope arm and the holding device with drive motor and counting wheel on the ground shows Fig. 2.2 and Fig. 2.3. The orientation of the liftsystem is 170°.

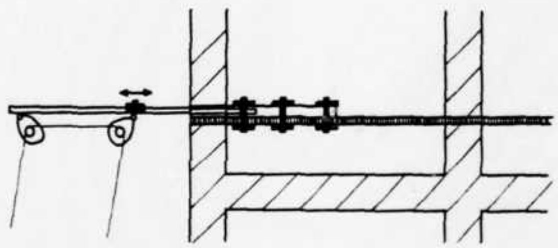


Fig. 2.2 Telescope arm in the height of 297m.

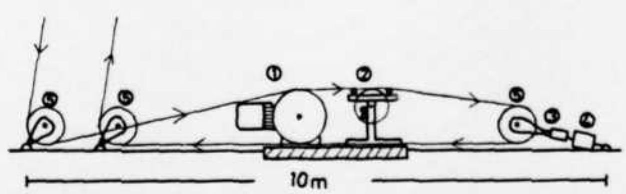
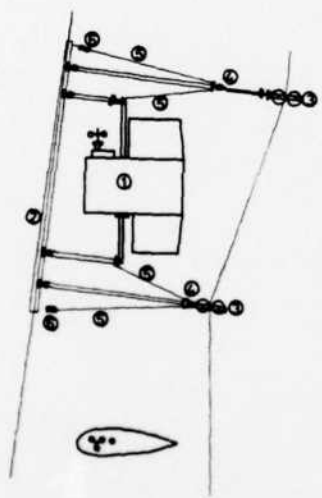


Fig. 2.3 Ground unit.
1: drive motor
2: count wheel
3: dynanometer
4: tension device
5: wheels

The frame holding the tethersonde package is positioned between the two ropes. It is fixed at one rope by means

of a clamp rail that is transported with the one rope. The other rope is guided through two double wheels (Fig. 2.4). The tethersonde package is installed in a streamlined designed body which can be turned round its roller beared vertical axis. Sonde and lining are well balanced about the axis of rotation. Additional control surfaces increase the reset power so that the lined tethersonde package works as a weather vane (Fig. 2.5). So the tethersonde package can be moved up and down with this liftsystem, the motor is remote controlled from the caravan.



1: streamlined designed body with tethersonde package
2: clamp rail
3: double wheel
4: telescope adjustment
5: steel rope
6: turnbuckle

Fig. 2.4 The frame holding the tethersonde package within the streamlined designed body.

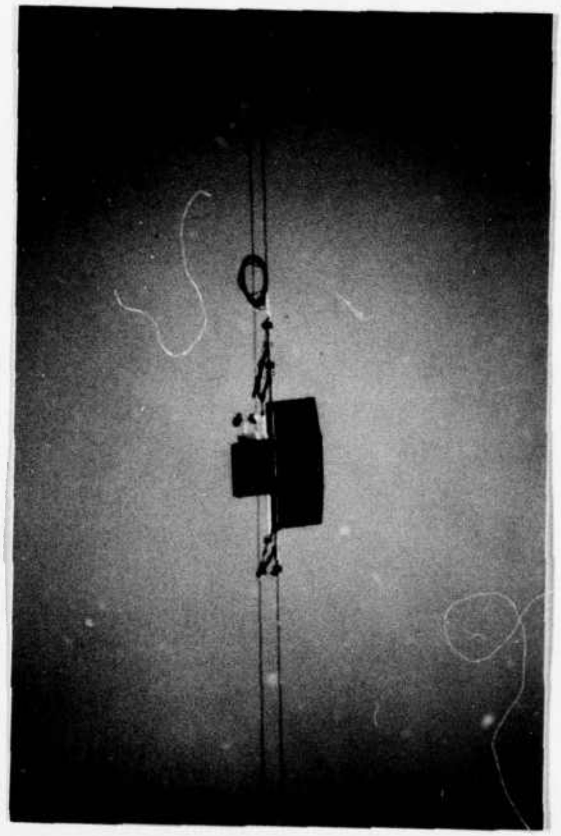


Fig. 2.5 The tethersonde within the streamlined designed body held by the frame.

2.1.2 Acquisition of tethersonde package data

The HF-signal of the tethersonde package is received by the ground station in the caravan and is processed into meteorological values. The pulses of the count wheel for height measurement are counted and stored in BCD-code. The values of the tethersonde are transmitted via a serial interface, the value of the counter via a parallel interface to the HP 85 calculator. The count value is computed into height above ground and stored on tape together with the meteorological parameters. In addition the data are printed out because of control reasons. A correction of wind speed and -direction due to mast influences and magnetic declination and of temperature because of the inertia of the sensor is

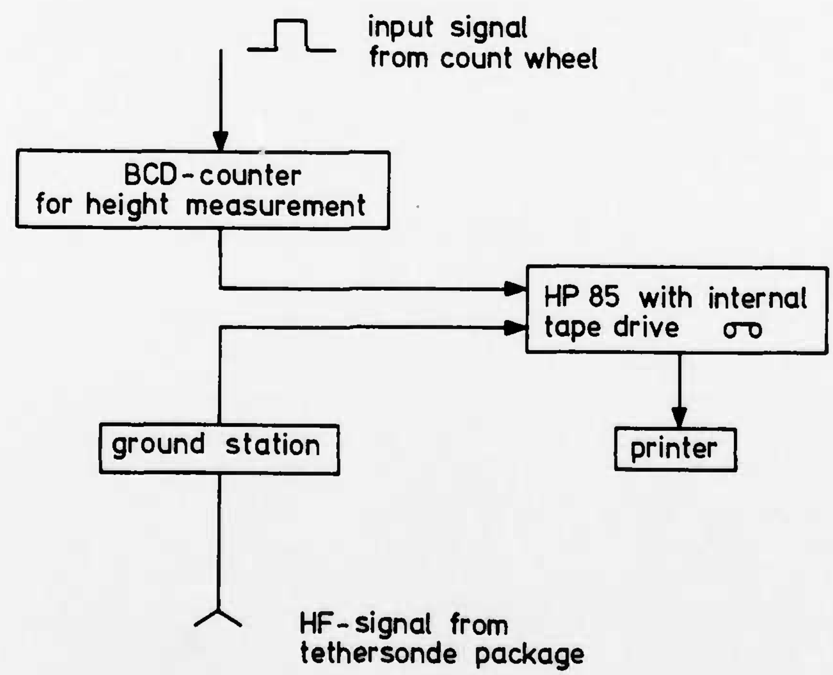


Fig. 2.6 Schematic block diagram of the data flow.

done later during further processing of the data. A schematic block diagram of the data flow shows Fig. 2.6.

2.1.3 Sodar registration

A monostatic sodar was used to get a continuous record of the temperature- and turbulence-structure in the atmosphere up to 500m height. The data were registrated on a facsimile recorder. The vertical accuracy is $\pm$15m at a pulse length of 100ms. The sodar was sited 220m north of the mast. So straight horizontal lines on the registration are due to reflections by the mast. This position close to the mast was chosen to keep the sodar on the same level as the base of the liftsystem, as the mast is sited on top of a hillock.

2.2 23./24. 10. 83

Northern Germany was influenced by a high pressure system with its centre east of the Alps. It transported very dry, quite warm air (xPs) in this area. The aerological sounding of Hannover-Langenhagen at 13.00h MEZ (Fig. 2.8) shows the base of this extreme dry air mass at the height of 975hPa. This suits to a subsidence of 400m. Beneath this air mass a surface layer of cold air (xP) formed due to little clouding (radiation). This layer remained during the day time. Later on the high pressure area moved south-east. An upper cold front of a low pressure system between Iceland and the North of Norway that affected the weather only a little approached from north-west. It brought up air of greater humidity so that it became cloudy in the morning. This frontal line was preceeded by a convergence line which passed Sprakensehl shortly after midnight. The weather situation is shown in the surface weather map (Fig. 2.7).

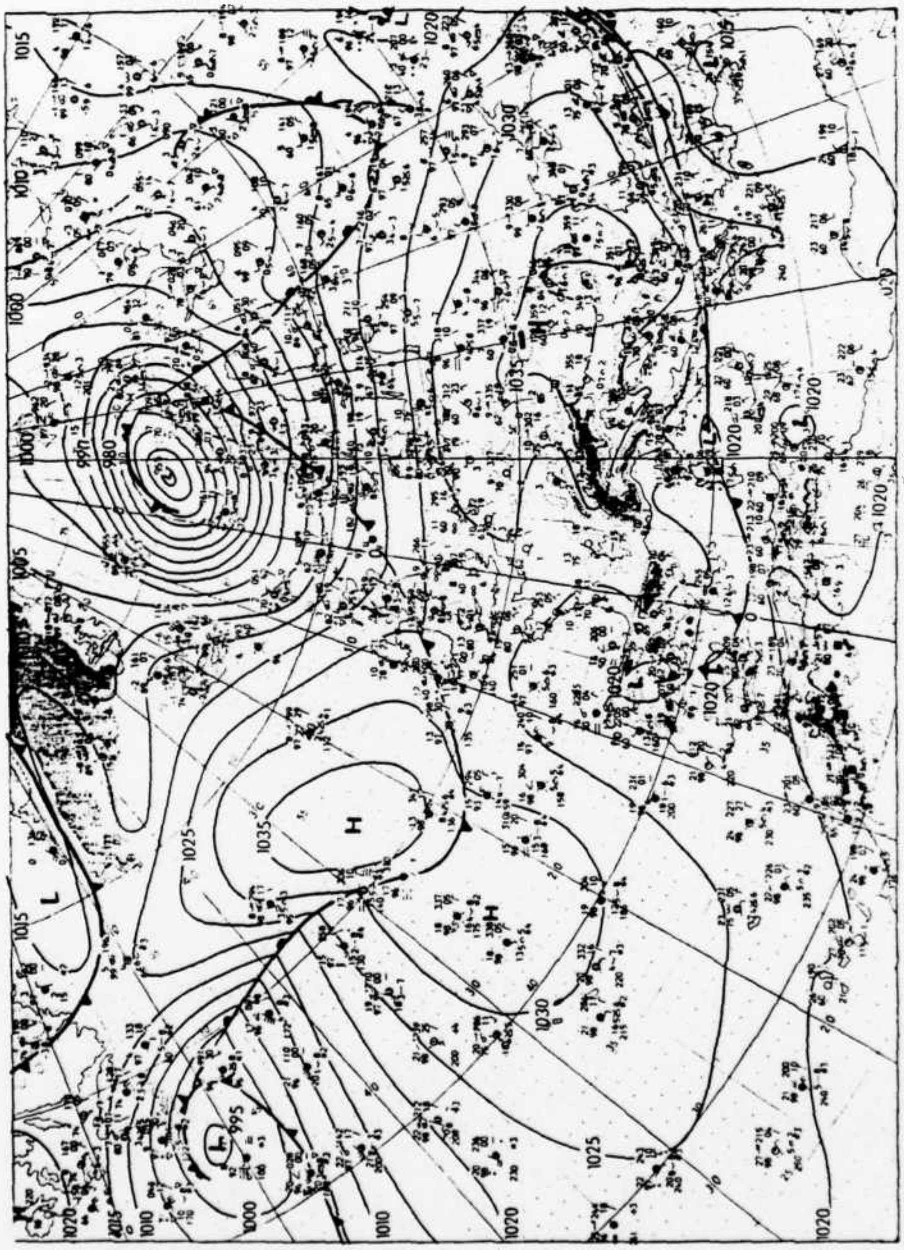


Fig. 2.7 Surface weather map 23.10.83 12h GMT.
(from: Europäischer Wetterbericht)

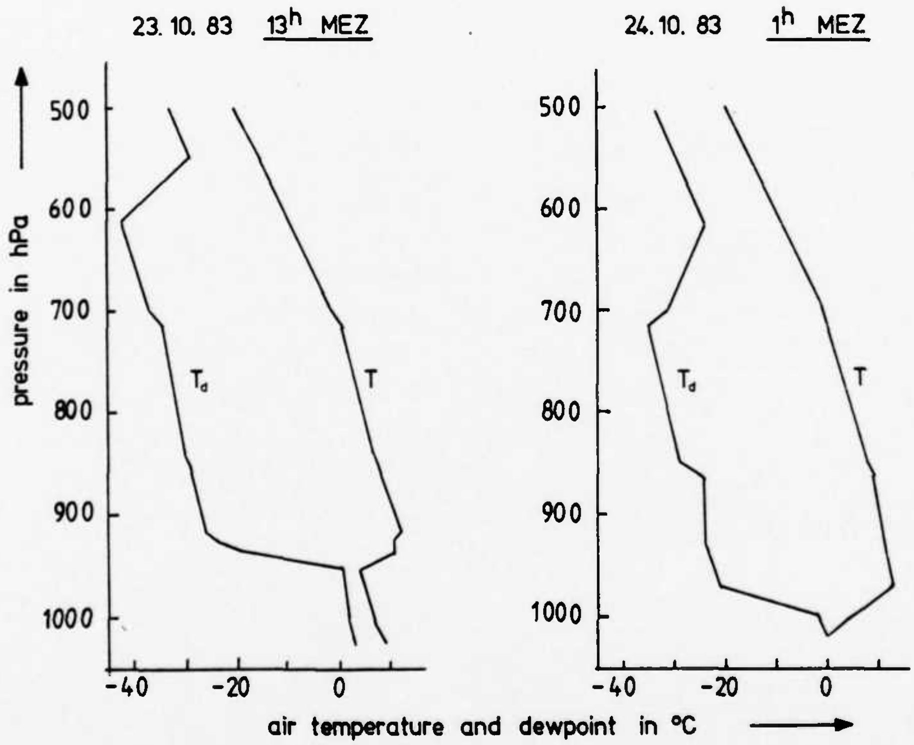


Fig. 2.8 Aerological soundings of Hannover-Langenhagen.

The sodar registration (Fig. 2.9.1) shows an intensive layer at a height of about 70m. This layer remains until the next morning. Further one can recognize scattering layers at upper heights which subside continuously from 400m at 17.30h MEZ to 200m at midnight. After 0.00h MEZ the structure of the boundary layer is disturbed by the draught of a convergence line.

The scattering layer and the isopleths of the temperature (Fig. 2.9.3) coincide well. The lowest scattering layer corresponds to a great temperature gradient which reaches the height of 70m. Above this ground inversion one can find a layer with a smaller temperature gradient. The thickness of this layer decreases until midnight. The structure of subsidence on the sodar registration is adequate to the air mass boundary between the cold air near the ground and the heated sub-polar air. This shows the intensification of the temperature gradient in the isopleths of the temperature. Additionally a heating of the air takes place because of the subsidence.

The isopleths of the relative humidity (Fig. 2.9.4) also demonstrate the subsidence. The values of the relative humidity point out an extreme aridity in the upper heights. The 10% isopleth subsides to the height of 200m at midnight. At higher levels the relative humidity reaches values as low as about 1%. A disturbance which can be seen in the isopleths of the relative humidity and the temperature between 0.30h and 1.00h MEZ has its origin in a convergence. With this convergence a lift of the air mass is correlated.

The structure of the isopleths of the horizontal visibility (Fig. 2.9.2) shows the subsidence of the dry heated air as well. An influence on the visibility by a change of the

relative humidity is normally observed below values of 70%. As the relative humidity at heights above 80m is not greater than 60% and, however, the visibility increases together with the subsidence the aerosol concentration must be smaller in the heated sub-polar air than in the cold air near the ground.

While the horizontal visibilities at 297m, 223m, 153m and 80m height increase successively the visibilities at the heights of 2m and 9m decrease continuously because of the increase of the relative humidity due to the nocturnal cooling (radiation). The approach of the front with a more humid air mass causes a decrease of visibility at all heights after 5.00h MEZ (Fig. 2.10).

The coincidence of the isopleths of the wind velocity (Fig. 2.9.5) with the sodar registration can be recognized well. The wind maximum of $10ms^{-1}$, a nocturnal low level jet, subsides corresponding to the scattering layer. After the passage of the convergence line the wind maximum ascends to more than 200m height (1.30h MEZ) to descend again to 150m (4.00h MEZ). Then the wind velocity increases to $12ms^{-1}$.

Fig. 2.9.1 - 2.9.5 Sodar, visibility, rel. humidity and wind velocity re 2:
at Sprakensehl.

Facsimile record of sodar registration

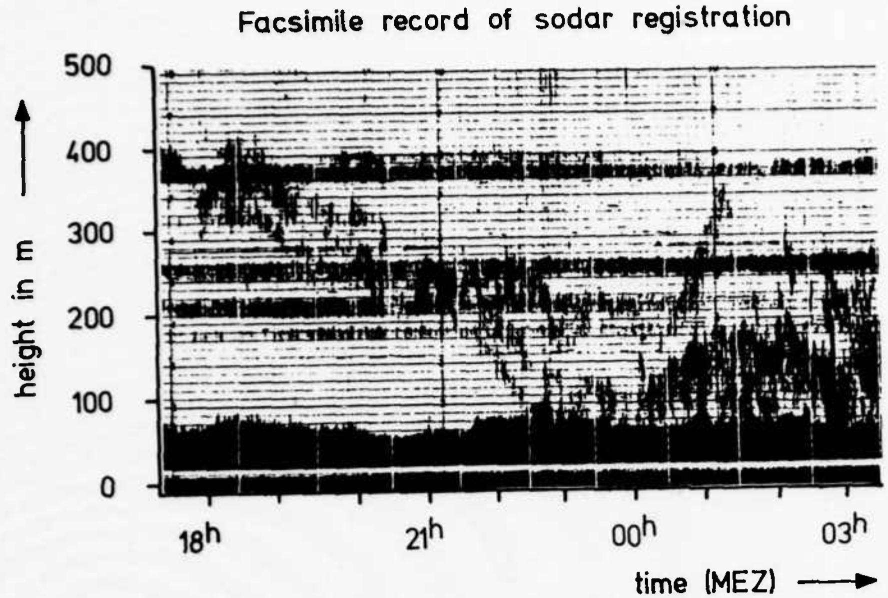


Fig. 2.9.1

Isopleths of visibility in km

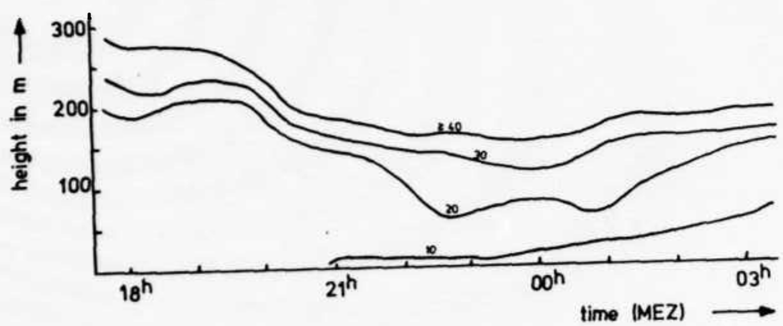


Fig. 2.9.2

Isopleths of air temperature in °C

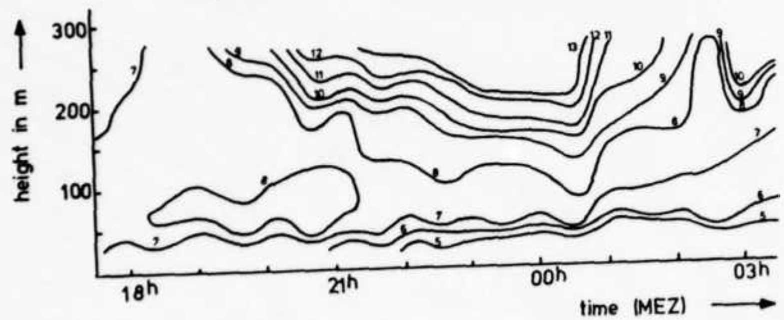


Fig. 2.9.3

Isopleths of relative humidity in %

Sodar, visibility, rel. humidity and wind velocity registrations at Sprakensehl. 23./24.10.83

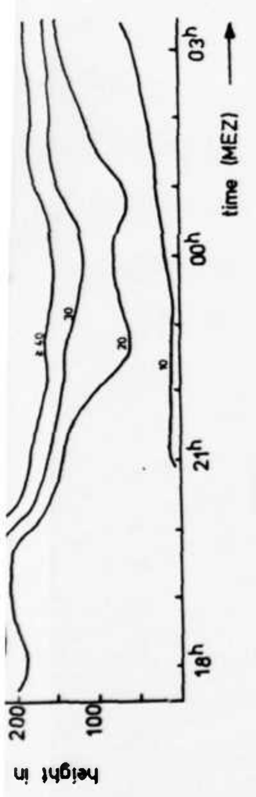


Fig. 2.9.2

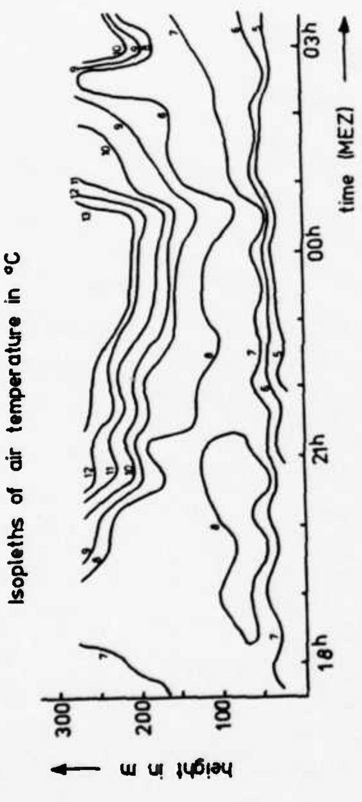


Fig. 2.9.3

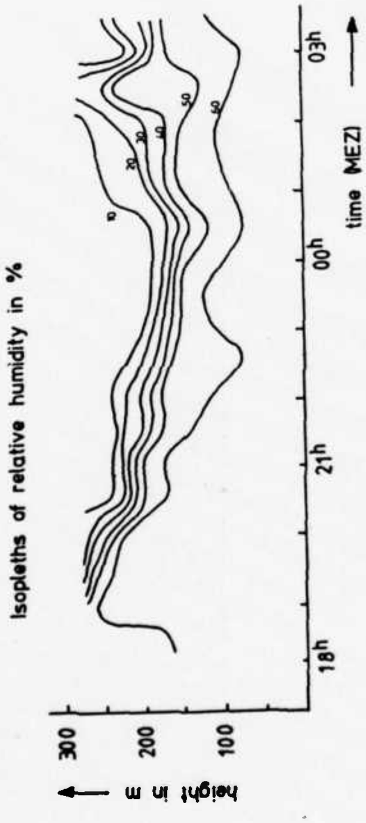


Fig. 2.9.4

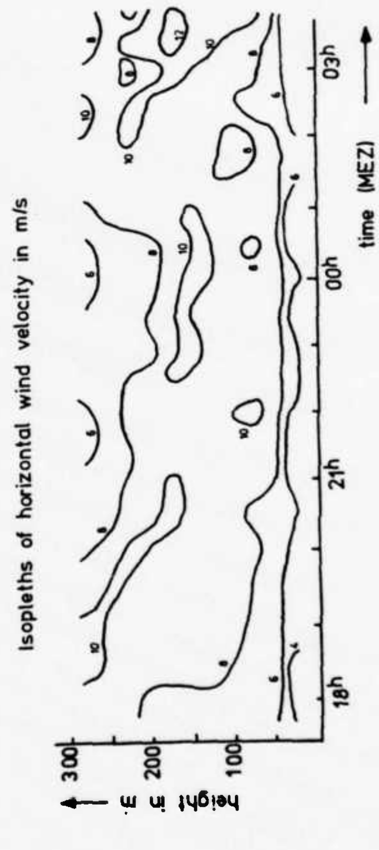


Fig. 2.9.5

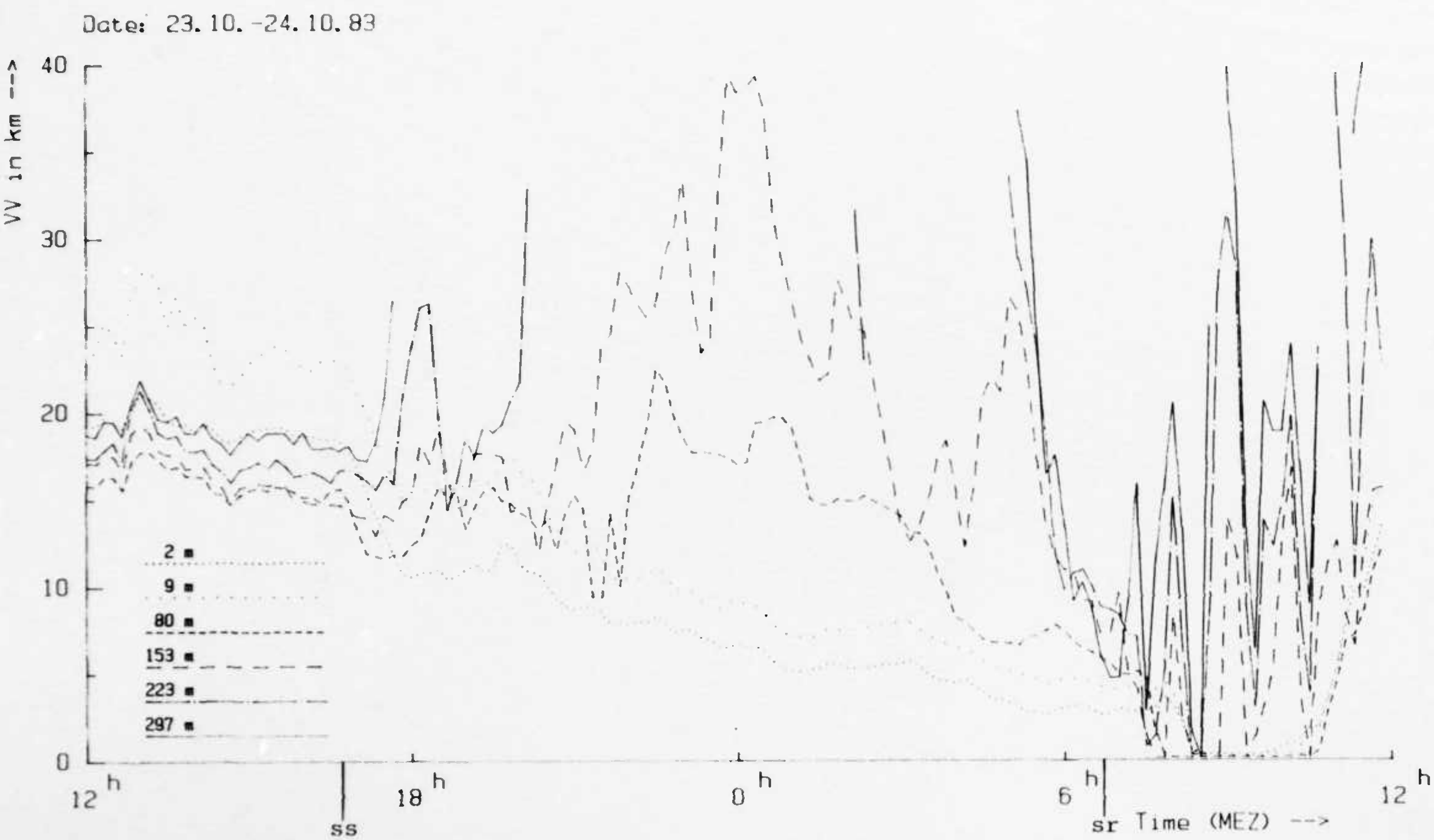


Fig. 2.10 Diurnal variation of visibility at the heights of 2m, 9m, 80m, 153m, 223m and 297m on 23./24.10.83.

2.3 29./30. 10. 83

Northern Germany was influenced by an extended high pressure system which reached from the North Atlantic over the British Islands to the Baltic. The centre of this high pressure was situated above Ireland and moved slowly southward until the morning of the 30. 10. 83. The Arctic Ocean low pressure system with its frontal lines did not influence the weather in the measuring area. At this day and the following night the wind velocity in Sprakensehl was low. In the afternoon the sky was slightly clouded and towards the evening it cleared up so that in the height of 2m the temperature decreased below the freezing point. During the night fog formed which took up and developed to a low stratus. The low stratus patches dispersed not sooner until noon.

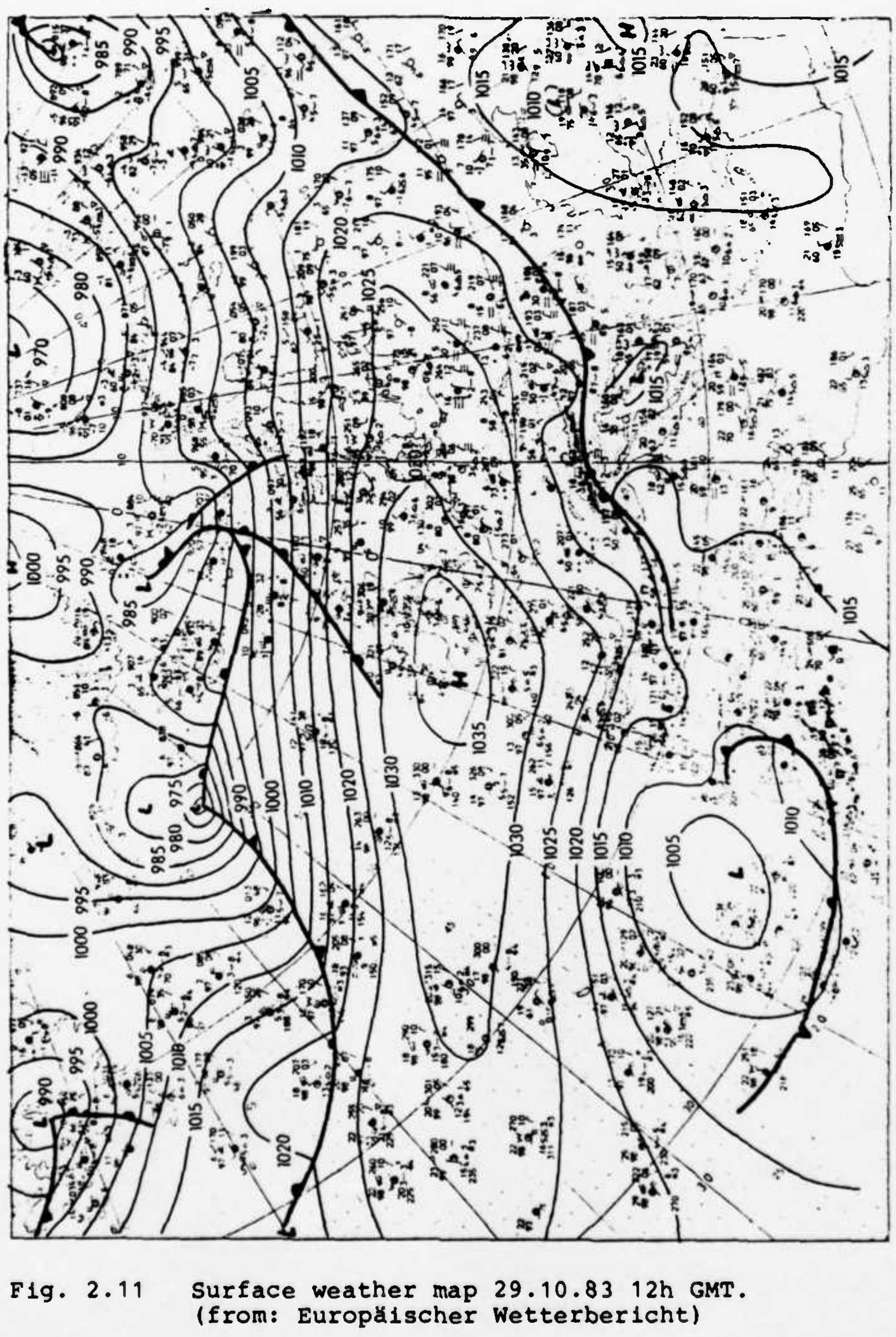


Fig. 2.11 Surface weather map 29.10.83 12h GMT.
(from: Europäischer Wetterbericht)

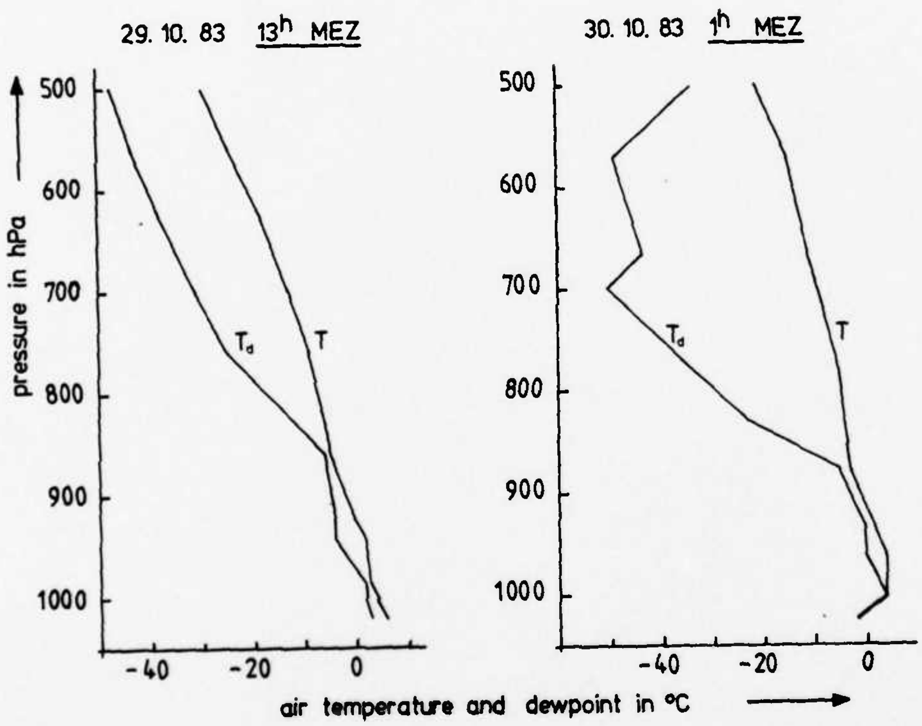


Fig. 2.12 Aerological soundings of Hannover-Langenhagen.

The sodar chart (Fig. 2.13.1) shows the end of convection at 16.00h MEZ. After that a backscattering begins at a height of about 350m. The scattering layer has a vertical thickness of 100m and subsides to a height of 100m until 18.00h MEZ. The ground inversion is not clearly to be seen on the sodar registration as the turbulence is too small because of the little wind velocity ($2ms^{-1}$). About 0.00h MEZ fog formed. At 7.00h MEZ the upper boundary of the fog reaches the height of about 350m. A scattering is received only from the upper boundary of the fog because of great cooling in this area. In the fog itself there is no back-scattering because the atmosphere in the fog is isothermal stratified.

The structure of subsidence on the sodar registration (16.00h - 19.00h MEZ) which reaches successively the measuring heights of 297m - 80m is closely correlated to the increase of visibility (isopleths Fig. 2.13.2, diurnal variation Fig. 2.14). In the measuring heights of 297m and 223m the visibilities reach values of about more than 40km while in 2m and 9m the visibilities decrease continuously until the fogformation begins (increase of the relative humidity be-cause of radiation). This increase of visibility is followed by a decrease which begins shortly after 18.00h MEZ at the height of 297m and reaches 80m at 20.00h MEZ. Afterwards the visibility increases at all heights (except 2m and 9m). A similar temporal variation of the visibility is also ob-served in other radiation nights.

This variation of visibilities is also recognizable in the isopleths of the relative humidity (Fig. 2.13.4), whose structure has a good correspondence to the structure of the visibility. A decrease of relative humidity is equal to an improvement of visibility.

The changes of the relative humidity become clearer in co-

herency with the isopleths of the temperature (Fig. 2.13.3). After the end of convection a cooling follows at a height of 150m - 300m together with an increase of relative humidity. Since 17.00h MEZ a heating of about 1K/h begins (decrease of the relative humidity corresponds to a subsidence of air about 100m/h). This heating continues for 2 hours and propagates from a height of 250m down to 50m. Later on the heating is detached by a gradual cooling (increase of relative humidity, decrease of visibility).

The reason for the subsidence is not fully clear. Probably it is caused by the divergence of cold air near the ground due to the topography (Fig. 2.15). Divergent flow in a high pressure system may be responsible for subsidence as well. The subsiding air is heated adiabatically. At 19.00h MEZ the heating is detached by a gradual cooling.

The formation of fog and the increase of its thickness can be found in all isopleths presentations. Remarkable is the strong increase of the wind velocity from $1ms^{-1}$ before fog formation to $6ms^{-1}$ afterwards (Fig. 2.13.5). The maximum of the wind velocity lays inside the fog layer. The increase of wind speed may be caused by a local circulation between cloudless areas and foggy areas. Hereby cold air flows near the ground into the relative warm fog area. There it ascends and flows back to the cloudless areas in the height. The vertical gradient of visibility at the upper boundary of the fog is 40km/100m, i.e. while the visibility at a height of 150m is less than 1km it reaches more than 40km at 250m height.

Fig. 2.13.1 - 2.13.5 Sodar, visibility, rel. humidity and wind v
at Sprakensehl.

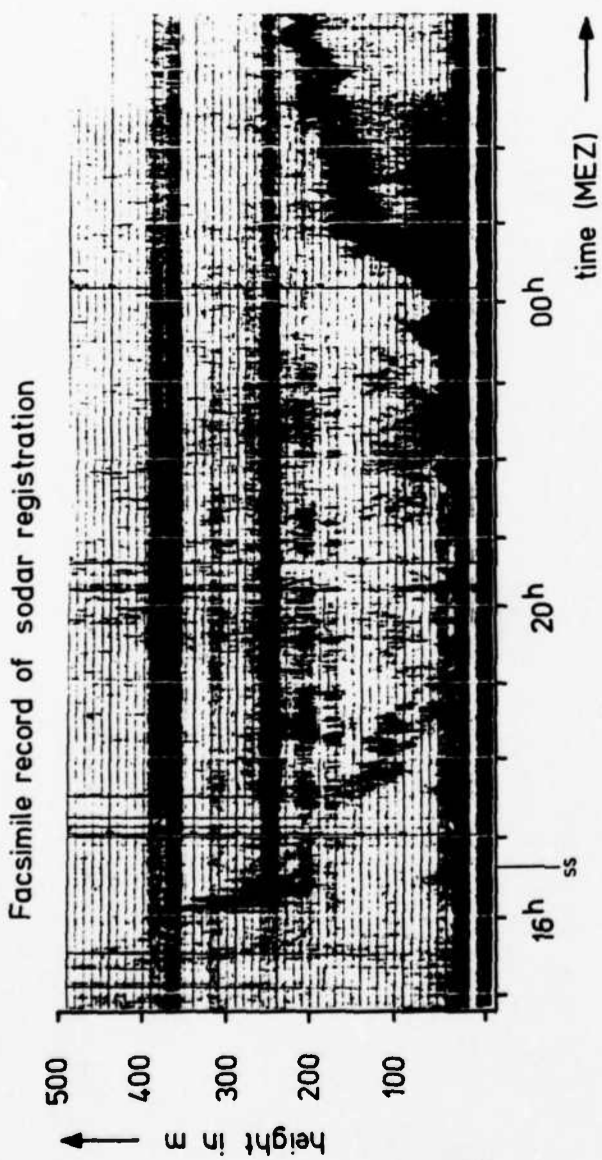


Fig. 2.13.1

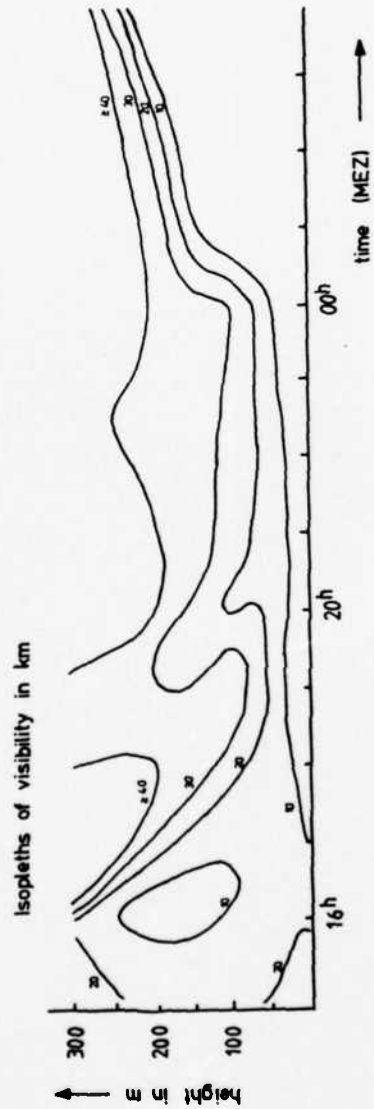


Fig. 2.13.2

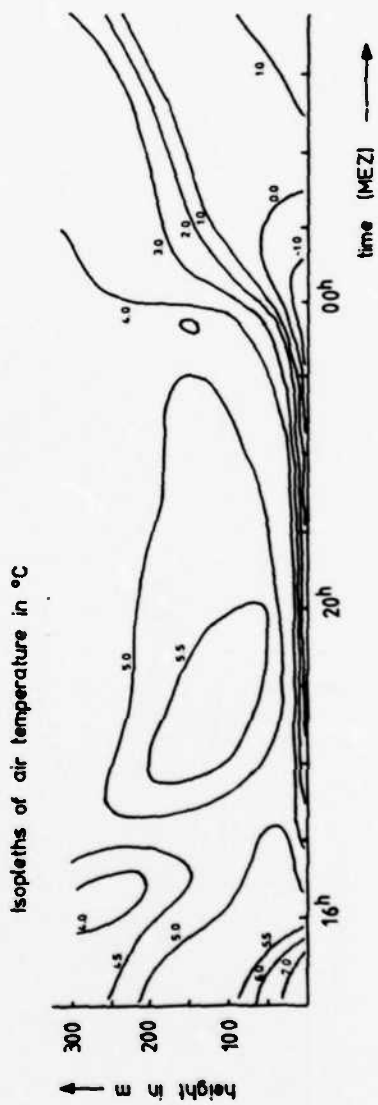


Fig. 2.13.3

odar, visibility, rel. humidity and wind velocity registrations
t Sprakensehl. 29./30.10.83

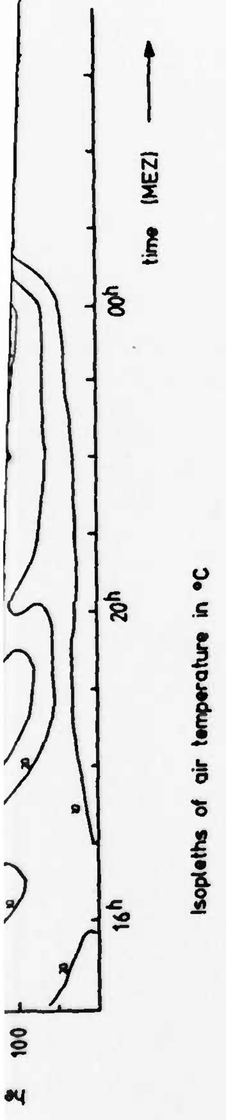


Fig. 2.13.2

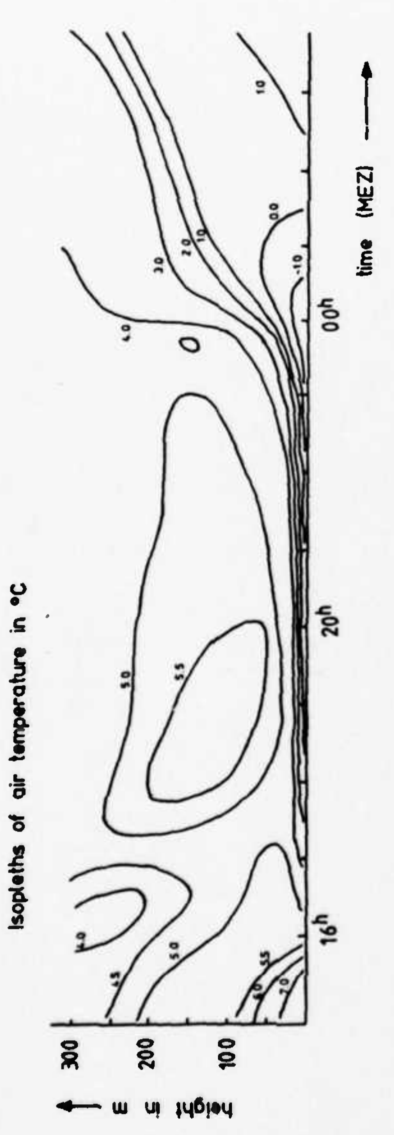


Fig. 2.13.3

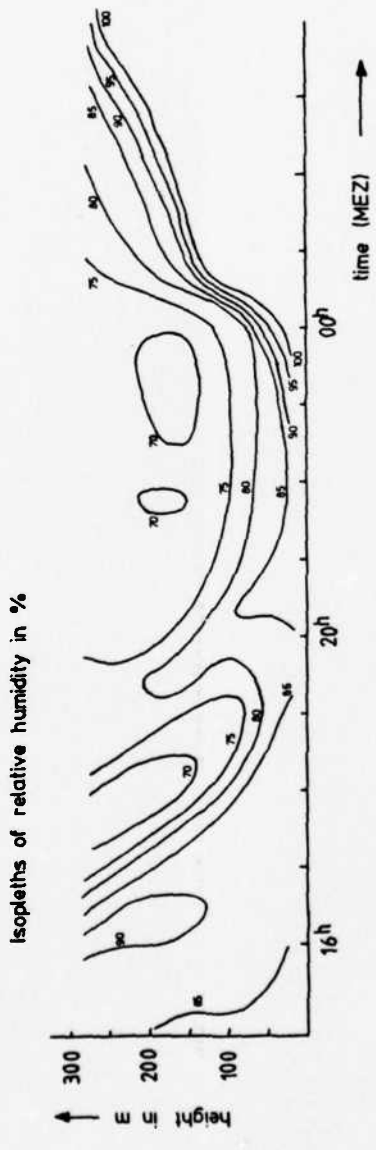


Fig. 2.13.4

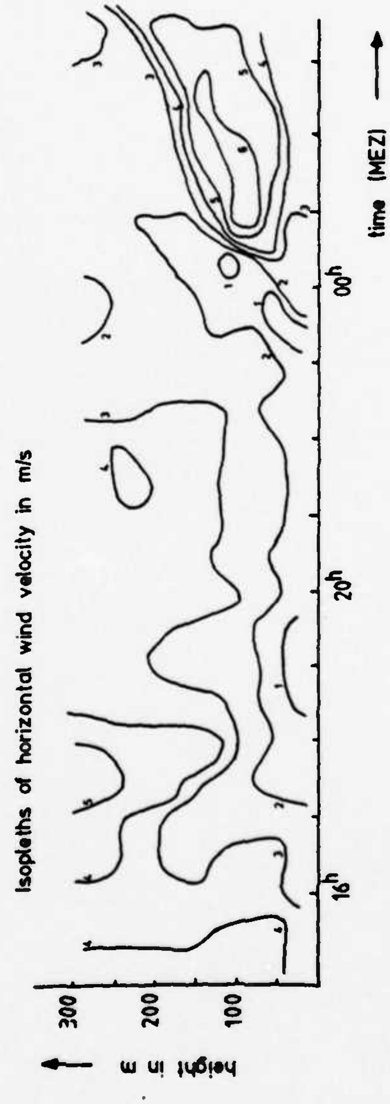


Fig. 2.13.5

2

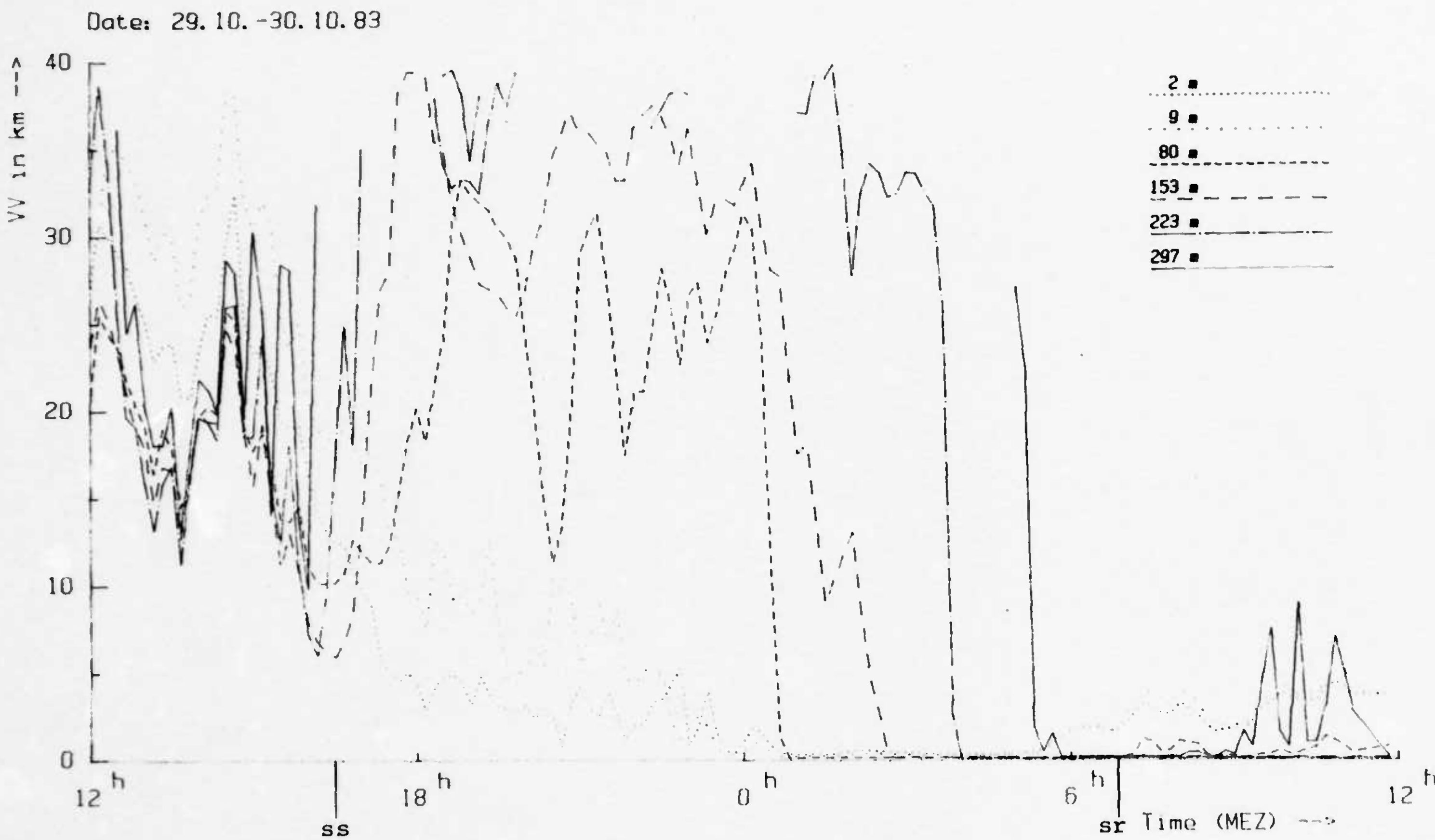


Fig. 2.14 Dirnal variation of visibility at the heights of 2m, 9m, 80m, 153m, 223m and 297m on 29./30.10.83.

—— 50m above sea level --- 100m above sea level

Fig. 2.15 Topography of the Lüneburger Heide.
Scale 1:1 000 000

3 Data processing

3.1 Data organization

For statistical means the Grosswetterlage (large scale weather pattern), the air mass and the synoptic data of six selected weather stations are added to the data measured in Sprakensehl. These synoptic data of Hamburg, Bremen, Hannover, Berlin-Tempelhof, Essen and Kassel consist of the station number (iii), the visibility (VV), the wind direction (dd), the wind speed (ff) and the topical weather situation (ww). The number of the stations are listed as follows

Hamburg	iii = 147
Bremen	iii = 224
Hannover	iii = 338
Berlin-Temp.	iii = 384
Essen	iii = 410
Kassel	iii = 438.

Now one complete 10min. data set has the form schematically illustrated in Fig. 3.1.

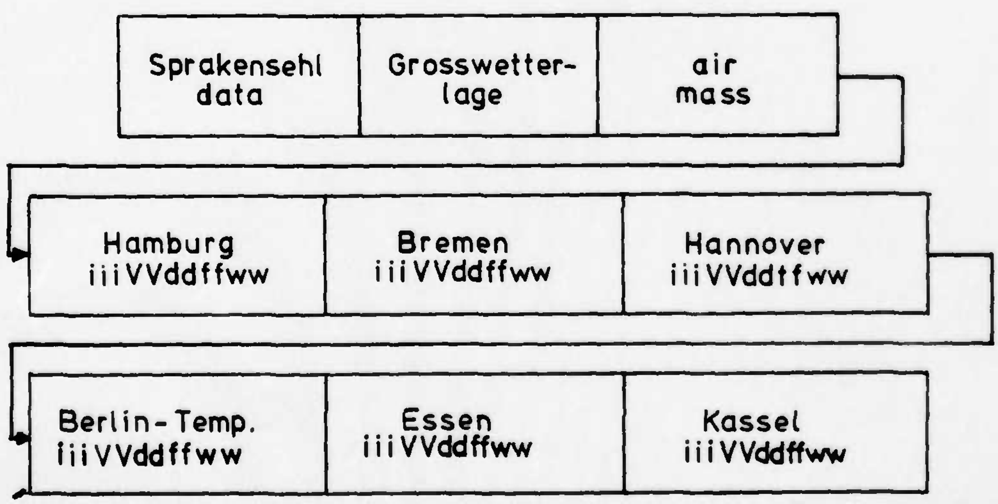


Fig. 3.1 Schematical data organization.

An example for the organization of the completed data sets gives Fig. 3.2.

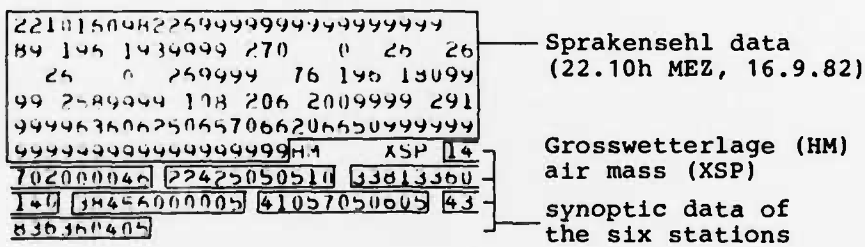


Fig. 3.2 Example of a complete 10min. data set.

These data are stored on magnetic tape (2400ft, 1600bpi) for further data processing with the CYBER 76 at the Regionales Rechenzentrum für Niedersachsen (RRZN).

3.2 Grosswetterlagen and air masses

A summary of the Grosswetterlagen of Europe after Hess and Brezowsky (1969) shows Table 3.1. The Grosswetterlagen are divided in the zonal, mixed and the meridional form of circulation. The German expression is followed by the abbreviation that is used in the data sets.

The air masses are taken out of the upper level chart (850hPa) at 1.00h MEZ from the Berliner Wetterkarte. An explanation of the abbreviations which were used for the air masses is given in the catalogue of the air masses for Central Europe (Table 3.2). Because of the data processing the abbreviations on magnetic tape are in capital letters.

A. Grosswetterlagen of the zonal form of circulation

1.	Westlage, antizyklonal	WA
2.	Westlage, zyklonal	WZ
3.	Südliche Westlage	WS
4.	Winkelförmige Westlage	WW

B. Grosswetterlage of the mixed form of circulation

5.	Südwestlage, anizyklonal	SWA
6.	Südwestlage, zyklonal	SWZ
7.	Nordwestlage, antizyklonal	NWA
8.	Nordwestlage, zyklonal	NWZ
9.	Hoch über Mitteleuropa	HM
10.	Hochdruckbrücke (Rücken) über Mitteleuropa	BM
11.	Tief Mitteleuropa	TM

C. Grosswetterlage of the meridional form of circulation

12.	Nordlage, antizyklonal	NA
13.	Nordlage, zyklonal	NZ
14.	Hoch Nordmeer-Island, antizyklonal	HNA
15.	Hoch Nordmeer-Island, zyklonal	HNZ
16.	Hoch Britische Inseln	HB
17.	Trog Mitteleuropa	TRM
18.	Nordostlage, antizyklonal	NEA
19.	Nordostlage, zyklonal	NEZ
20.	Hoch Fennoskandien, antizyklonal	HFA
21.	Hoch Fennoskandien, zyklonal	HFZ
22.	Hoch Nordmeer-Fennoskandien, antizyklonal	HNFA
23.	Hoch Nordmeer-Fennoskandien, zyklonal	HNFZ
24.	Südostlage, antizyklonal	SEA
25.	Südostlage, zyklonal	SEZ
26.	Südlage, antizyklonal	SA
27.	Südlage, zyklonal	SZ
28.	Tief Britische Inseln	TB
29.	Trog Westeuropa	TRW
30.	Übergangslage	UE (=9 on tape)

Tab. 3.1 Summary of the Grosswetterlagen after Hess and Brezowsky (1969).

abbreviation	climatological specification
cA	continental arctic air
xA	arctic air
mA	maritime arctic air
cP	continental sub-polar air
xP	sub-polar air
mP	maritime sub-polar air
cPs	heated continental sub-polar air
xPs	heated sub-polar air
mPs	maritime heated sub-polar air
cSp	continental air of the middle latitudes
xSp	air of the middle latitudes
mSp	maritime air of the middle latitudes
cS	continental sub-tropical air
xS	sub-tropical air
mS	maritime sub-tropical air
cT	continental tropical air
xT	tropical air
mT	maritime tropical air

Tab. 3.2 Catalogue of the air masses for Central Europe by Manfred Geb.

3.3 Statistics

This chapter describes first steps in the statistical consideration of the measured data which were processed for this purpose on the CYBER 76 at the RRZN. Not a detailed investigation but a general survey on the data is presented covering the time period 16.9.82 - 15.9.83. The visibility data in the time 6. - 13.2.83 were excluded as they were falsified due to icing and snow accumulation in front of the measuring channels. Readings of the visibility meters which were obviously affected by temporary hardware failures had to be ommitted as well. So the data of 297 days were considered.

Within this one years' period there were less zonal (23.2%) but more mixed (38.7%) and meridional (38.1%) circulation patterns over Central Europe. A frequency matrix correlating Grosswetterlagen and air masses is shown in Fig. 3.3.

In Fig. 3.3.1 - 3.3.6 relative frequencies of the visibilities are presented for the heights of 2m to 297m. The width of classification is 2km except the width of the first (less than 2km) and the last class (36km and larger). The heights of 2m to 80m show a relative maximum between 2km and 10km that is caused by the influence of haze and mist. Small visibilities in the upper heights frequently are due only to clouds in which the visibility is less than about 1km. So the distributions for 153m to 297m height show a relative maximum only between ≤50m and 2km. All measuring levels have an absolute maximum for the frequency of visibilities greater than 36km which increases with height. Another relative maximum is common to all heights for visibilities of 20km. It has to be investigated if it is due to the mean state of the atmosphere or if the sensitivity curve of the visibility meters is responsible for this

	CT	MT	CA	XT	XA	CS	CP	CPS	CSP	MA	XP	AS	MS	MSP	XPS	XSP	MPS	MP	ROW TOTAL
MNA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MNZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SEA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HFA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HNFZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HFZ	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	3
SZ	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	3
WW	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	4
NFA	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	0	0	4
SEZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	4
NEZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	5
HF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	5
HNFA	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2	0	0	5
SWZ	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3	2	7
WA	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	3	3	1	12
NWZ	0	0	0	0	0	0	0	0	0	3	1	0	0	3	0	0	1	6	14
SWA	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	2	3	4	14
TRM	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	12	15
WS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	10	16
HM	0	0	0	0	0	0	1	1	0	5	3	0	0	0	2	0	0	4	16
TM	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	1	0	10	17
TH	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1	7	6	18
NWA	0	0	0	0	0	0	0	0	0	2	1	0	3	3	4	3	0	2	18
HM	0	0	0	0	1	0	1	1	1	1	1	1	0	1	1	7	0	3	19
BM	0	0	0	0	0	0	0	2	1	0	0	1	2	2	3	3	3	9	26
TRW	0	0	0	1	0	1	0	0	0	0	1	6	3	1	2	5	6	9	35
WZ	0	0	0	0	0	0	0	0	1	2	1	0	5	4	1	0	2	21	37
COLUMN TOTAL	0	0	0	1	1	1	2	5	7	13	13	17	17	17	26	33	35	109	297

Fig. 3.3 Frequency matrix correlating Grosswetterlagen and air masses. Columns represent airmasses, rows represent Grosswetterlagen.

maximum. Generally the frequency distributions for the upper levels look quite similar whereas there are greater differences between the lower levels.

Mr. Heaps of the U.S. Army Atmospheric Sciences Laboratory will be consulted about the most suitable way of presenting further frequency distributions of visibility. Frequency distributions as well as diurnal variations of the visibility both related to the Grosswetterlagen will be made soon. In addition special cases will be investigated in detail.

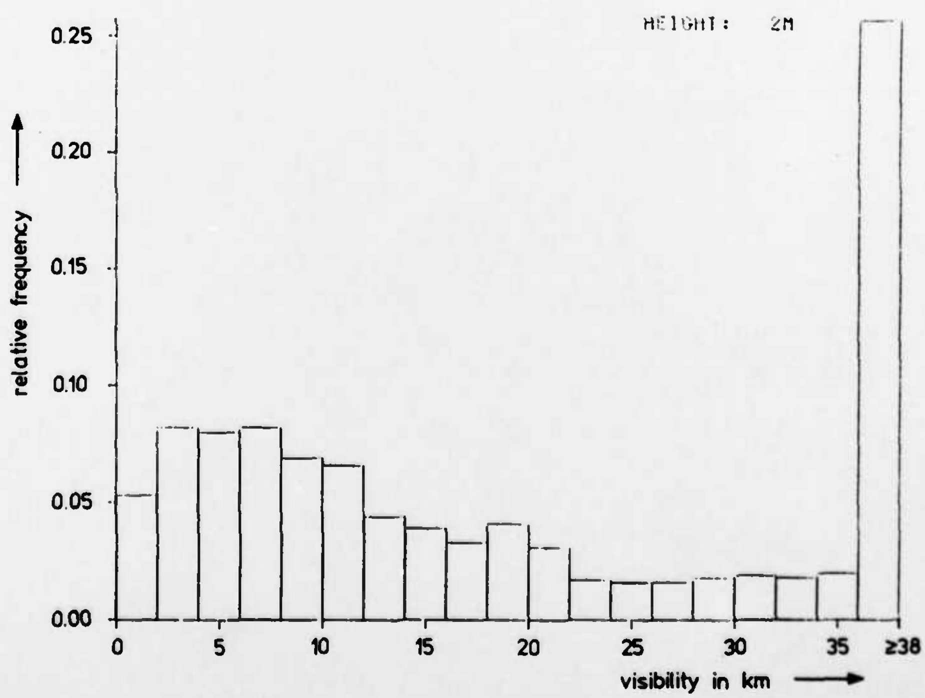


Fig. 3.4.1 Frequency distribution of visibility for the height of 2m.

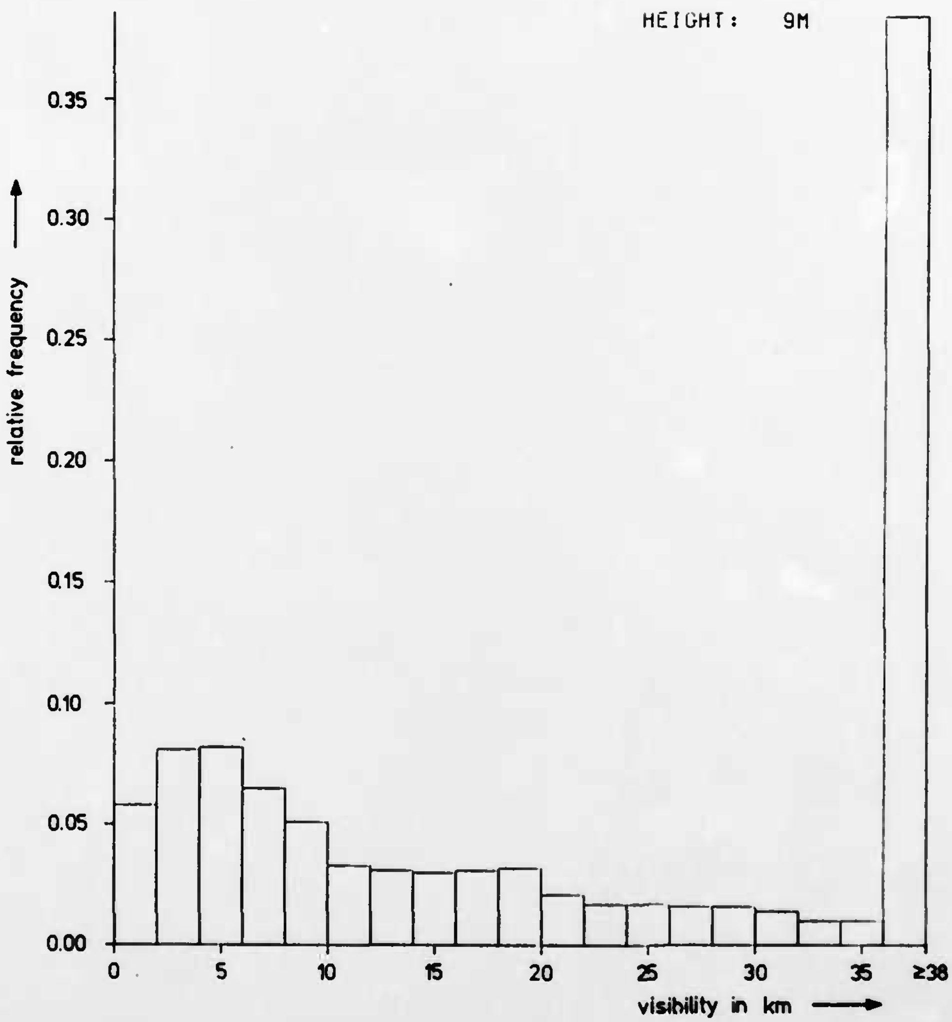


Fig. 3.4.2 Frequency distribution of visibility for the height of 9m.

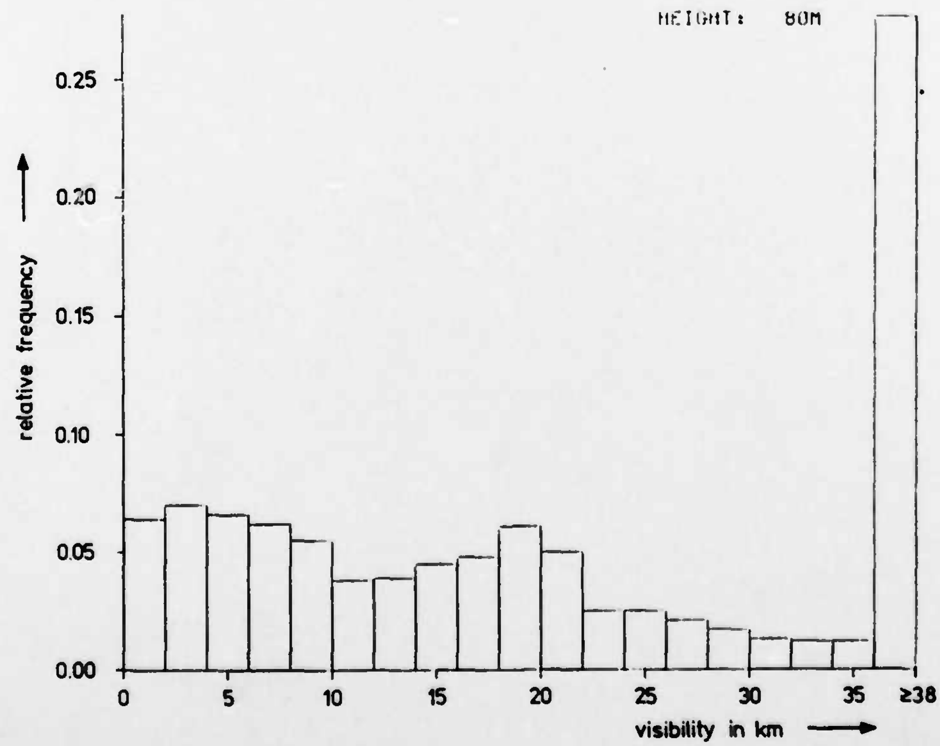


Fig. 3.4.3 Frequency distribution of visibility for the height of 80m.

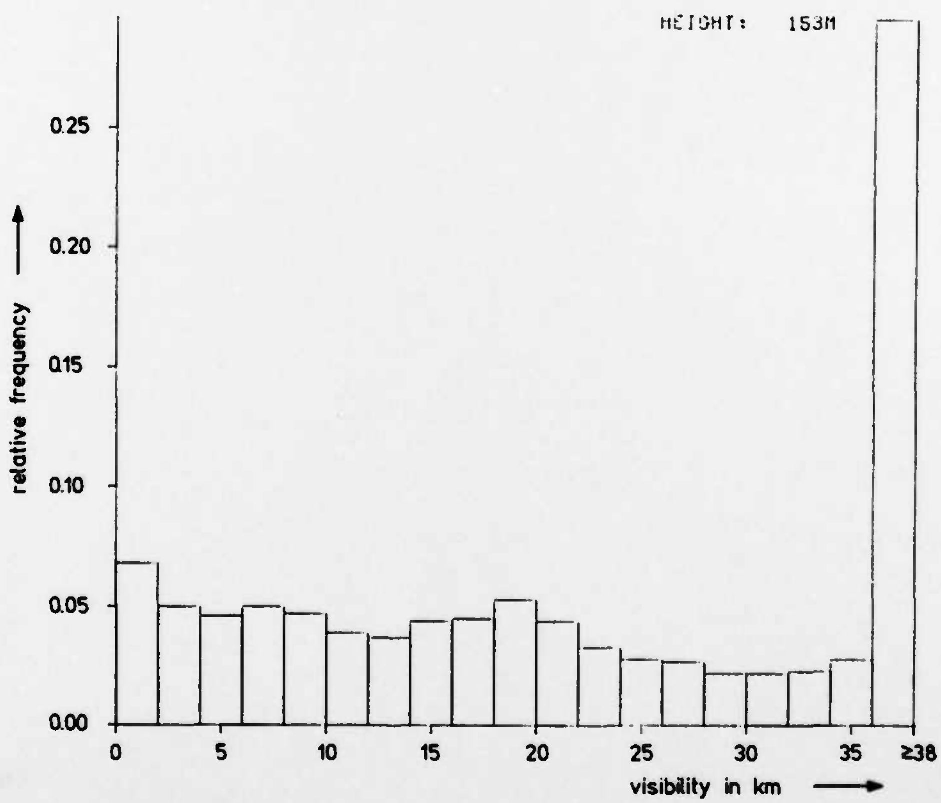


Fig. 3.4.4 Frequency distribution of visibility for the height of 153m.

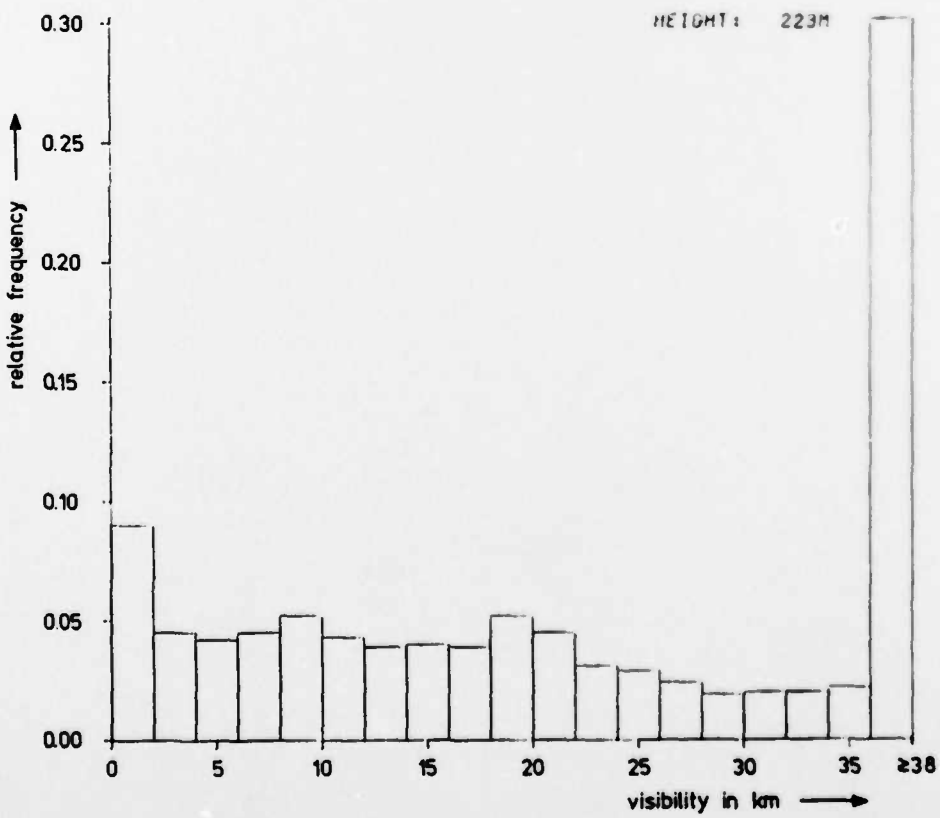


Fig. 3.4.5 Frequency distribution of visibility for the height of 223m.

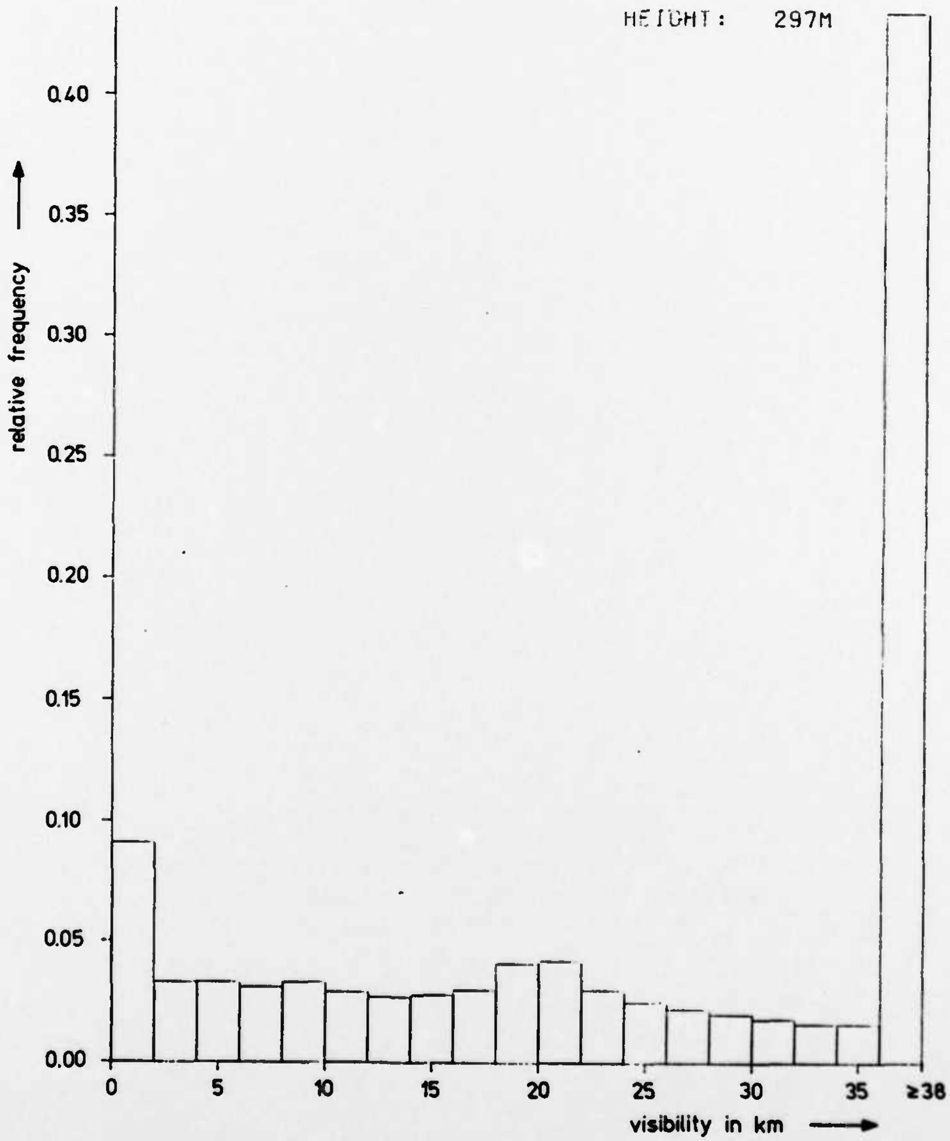


Fig. 3.4.6 Frequency distribution of visibility for the height of 297m.

4 Acknowledgement

The work on the project described within this report was organized in detail by Dipl.-Met. B. Pietzner, who also managed to overcome a lot of smaller or larger troubles in the hard-ware. Mr. Surkow was able to convince the AEG, the form delivering the visibility meters, that their instruments had to be improved in some details, so that the quality of the data could be improved. Out of our students mainly Martina Falke and Hartmut Gindler were busy in a carefull data analysis while Andreas Siemer organized to bring the large amount of data on the big computer and to start the first statistical investigation. Again the Deutsche Bundespost, Funkübertragungsstelle Sprakensehl was very cooperative especially when we started to operate our tethersonde-system. So as far as I can see the project is really on the way in schedule. Thanks to all of those who were engaged to reach the state documented in this report.

Hannover 24.2.1984 Rainer Roth

(Principal investigator)

END

DATE
FILMED

4-84

DTIC

and Brezowsky (1969).

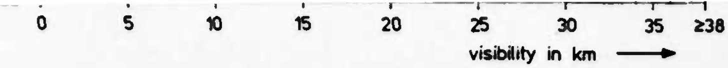


Fig. 3.4.1 Frequency distribution of visibility for the height of 2m.

Fig. 3.4.2 Frequency distribution of visibility for the height of 9m.

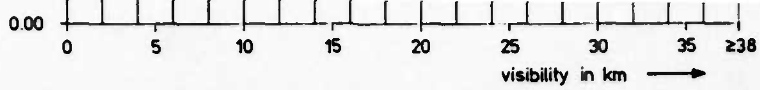


Fig. 3.4.3 Frequency distribution of visibility for the height of 80m.

visibility in km →

Fig. 3.4.4 Frequency distribution of visibility for the height of 153m.

Fig. 3.4.5 Frequency distribution of visibility for the height of 223m.

Fig. 3.4.6 Frequency distribution of visibility for the height of 297m.

DTIC